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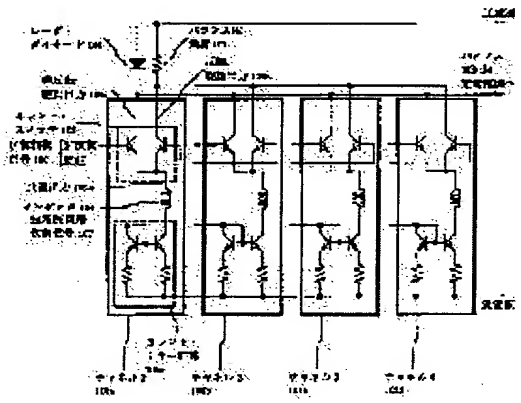
(54) LASER DRIVING CIRCUIT

(57)Abstract:
PURPOSE: To relieve restriction on a power supply voltage by the forward voltage drop of a laser by enabling driving of the laser with the low power supply voltage.
CONSTITUTION: This laser driving circuit is composed of the laser 101 having a light emission central wavelength of ≤630nm, a constant current circuit 105, a current changeover means 103 connected in series to this constant current circuit and an inductor 104 connected in series to the constant current circuit. A pulse voltage is otherwise generated in the inductor by passing pulse current to the indicator by a high-frequency current generating means and the current from this inductor is added to a laser driving current. The need for preparing a power source of a high voltage for laser driving or a special boosting means is eliminated by driving by the power supply voltage of ≤5V. The lower electric power consumption and the smaller size and lower cost of the device are thus resulted.



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CLAIMS

[Claim(s)]
[Claim 1] Emission center wavelength 680nm It consists of an inductor and is [the following laser and] supply voltage. Laser drive circuit characterized by driving said laser less than [5V].
[Claim 2] The laser drive circuit characterized by the current switch means which switches laser, the current regulator circuit which sets up the magnitude of the current which drives this laser, and the path of a current of connecting with a serial in this current regulator circuit, and flowing to this current regulator circuit, and changing from the inductor connected to the serial to said current regulator circuit.
[Claim 3] Claim characterized by the current switch means which switches laser, the current regulator circuit which sets up the magnitude of the current which drives this laser, and the path of a current of connecting with a serial in this current regulator circuit, and flowing to this current regulator circuit, and changing from the inductor connected to the serial to said current regulator circuit 1 Laser drive circuit of a publication.
[Claim 4] The laser drive circuit according to claim 2 or 3 characterized by connecting said inductor and said current regulator circuit to the common output of said current switch means at a serial, and connecting the noninverting drive output of each of said current switch means to the drive terminal of laser.
[Claim 5] The laser drive circuit according to claim 2 or 3 characterized by connecting an inductor to the common output of said current switch means, connecting the reversal drive output of this current switch means to a current regulator circuit, and connecting the noninverting drive output of this current switch means to the drive terminal of laser.
[Claim 6] At least 2 Even if as few as the current regulator circuit of an individual 2 The current switch means of an individual, At least 2 It has the inductor of an individual. The number of said current regulator circuit, It is [claim 2 characterized by connecting to the drive terminal of laser at juxtaposition the noninverting drive output of this current switch means by which the number of said current switch means and the number of said inductor spread a phase etc. thru/or] a laser drive circuit given in either among 5.
[Claim 7] the inside of said current regulator circuit -- at least -- 2 the current which flows in a circuit -- a phase -- claim 2 characterized by controlling said current switch means to be equal and to carry out sequential supply of the drive current from this current regulator circuit at laser thru/or the inside of 6 -- laser drive circuit given in either.
[Claim 8] The inductance of an inductor 1 microhenry It is [claim 2 characterized by being above thru/or] a laser drive circuit given in either among 7.
[Claim 9] Laser, a high-frequency-current generating means generate the frequency which reduces the return light noise of this laser, the inductor that are connected to the output of this high-frequency-current generating means, exceed the output voltage of this high-frequency-current generating means, and generate the pulse-like electrical potential difference of said frequency, and the current which flow to this inductor 1 The laser drive circuit by which it is adding-to said laser drive current-current which has rectification means restrict to direction and flows this inductor characterized.
[Claim 10] In the optical information record approach which records information on an optical recording medium by driving semiconductor laser using two or more channels located in a line with juxtaposition, and obtaining the laser beam output of a multiple value Each above-mentioned channel by having a current regulator circuit, the inductor by which series connection is carried out to this current regulator circuit, and the switching means which connects this inductor to the above-mentioned semiconductor laser electrically, and controlling this switching means The optical information record approach of supplying a current to the above-mentioned semiconductor laser intermittently, and obtaining the laser beam output of a multiple value from the inductor of the arbitration of two or more above-mentioned channels.

[Claim 11] The optical information record approach according to claim 10 which arranges a bypass to juxtaposition at said semiconductor laser, controls said switching means, supplies a current to semiconductor laser by connecting said inductor to said semiconductor laser, and does not supply a current to semiconductor laser by connecting said inductor to the above-mentioned bypass.
[Claim 12] The optical information record approach according to claim 11 that the load for balance is arranged at said bypass.
[Claim 13] The optical information record approach according to claim 10 which two or more above-mentioned channels are arranged at a serial, controls said switching means, supplies a current to semiconductor laser by connecting said inductor to said semiconductor laser to a positive supply and a negative supply, and does not supply a current to semiconductor laser by connecting said inductor to the above-mentioned constant ******.
[Claim 14] By controlling said switching means, it is [claim 10 which forms a long and slender mark and records information on an optical recording medium thru/or] the optical information record approach given in either among 13.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the drive circuit of laser.
[0002]
[Description of the Prior Art] An optical disk has the description that storing of extensive information is possible and exchange of a medium is possible, and is spreading quickly [current]. It is common to the light source of this optical disk to use the semiconductor laser diode of a vertical single mode. However, when the light from the outside returns in the resonator of semiconductor laser, semiconductor laser causes fluctuation of the luminescence reinforcement called a return light noise. Since this return light noise reduces the quality of a regenerative signal, when attaining densification, it poses a problem.
[0003] in order [then,] to solve this problem -- Japan public presentation patent public-relations: -- Showa 56-37834 etc. -- well-known -- as -- a laser drive current -- several 10- hundreds MHz By superimposing the high frequency current, the longitudinal mode of laser is formed into multi-mode and the technique of reducing the coherence of a laser beam and reducing a return light noise is known. With this conventional technique, the source of a direct current and the source of RF alternating current are connected to laser at coincidence, and the configuration which superimposes the high frequency current on a laser drive current is taken. For this reason, the maximum of a laser drive current is restricted with the supply voltage of the source of a direct current, and the source of RF alternating current.
[0004] Moreover, the magneto-optic disk and phase change mold disk which are a kind of an optical disk narrow down the light from a laser light source, heat a record medium locally, and are recording information by forming a record mark. In these optical disk units, it is required for coincidence to control a mark configuration correctly, reducing a record mark, in order to aim at improvement in recording density, maintaining the dependability of recording information. this purpose -- Japan public presentation patent public-relations: -- Taira 5-298737 etc. -- the record control technique which forms a record mark in a precision by the light pulse with two or more sound power levels is developed so that it may be well-known.
[0005] It is drawing about the example of a configuration of the laser drive circuit in the case of performing record control. 8 Drawing 8 It is drawing about the corresponding example of a laser drive current wave form and a laser drive circuit of operation. 9 It is shown. this configuration 3 Current Miller circuit of a network 105a Current switch 103 minding -- juxtaposition -- connecting -- addition control signal from a record wave control circuit 106 Follow and add each current suitably. 4 Gradual laser drive current 302 namely, -- 4 Gradual luminescence level on the strength is generated.
[0006] the case of this circuitry -- laser diode 101 **** -- current switch 103 Current Miller circuit 105a It is inserted in a serial and a voltage drop arises by the circuit element which constitutes these. For this reason, laser diode 101 In order to drive by the luminescence reinforcement of arbitration, the supply voltage of the more than which applied the voltage drop by the drive circuit was required for the maximum electrical potential difference between laser drive terminals.
[0007]
[Problem(s) to be Solved by the Invention] In order to raise the recording density of an optical disk, it is most direct to reduce the path of the optical spot which shortens the wavelength of the laser light source to be used and is used for record playback, and it is effective. Short wavelength-ization of the semiconductor laser diode generally used as the current light source is performed by changing the ingredient of a component and expanding a band gap. However, it has been hard and become to fully raise carrier concentration as a band gap is expanded, and the resistivity of the ingredient itself has been

increasing by this. For this reason, for future semiconductor laser diode, it is likely to expand to high-priced [this] by modification of the component ingredient accompanying short-wavelength-izing.
[0008] Moreover, it is necessary with large-capacity-izing by improvement in recording density to also accelerate the rate of record playback. For this reason, more nearly high-speed actuation is demanded also of the circuit element which performs signal processing. The semiconductor device which generally performs high-speed operation operates with supply voltage lower than before in many cases. Moreover, there is an inclination to reduce supply voltage to this and coincidence for the purpose of low-power-izing of equipment itself. current -- as a power source +5V +12V -- or -- although the equipment which operates in response to supply of only +5V is common -- the future -- these +5V Becoming the following single power supplies is expected.
[0009] When optical-magnetic disc equipment performs record by the light modulation method, the semiconductor laser of the light source is driven by the pulse current of the large amplitude, and generates the light pulse of high luminescence level on the strength by short width of face. It is drawing about an example of the laser drive circuit of the conventional magneto-optic disk. 8 It is drawing about the example of operation. 9 It is shown. Moreover, it is drawing about an example of the drive property of semiconductor laser. 10 It is shown. Luminescence reinforcement IOUT 1003 For raising, it is forward current of laser. IF 1001 It becomes large and is an electrical potential difference between anode cathodes. VF 1002 Since it expands, the upper limit decided by supply voltage exists in a laser drive current. That is, it is impossible to drive laser with the power source of an electrical potential difference lower than the sum of the voltage drop of a laser drive circuit and a laser forward voltage drop.
[0010] In order to solve these problems, the pressure up of the power source of a low electrical potential difference is carried out, and a high electrical potential difference is obtained continuously. DC-DC There is a means of a converter etc. However, it is DC-DC only because of a laser drive circuit. It is disadvantageous to prepare a converter in respect of the miniaturization of equipment, and cost.
[0011] So, in this invention, by combining an inductor with a laser drive circuit, these problems are solved and the limit to the supply voltage by the laser forward voltage drop is eased. Thereby, since the drive of the laser in supply voltage lower than before is possible even when the forward voltage drop of laser goes up with short-wavelength-izing of semiconductor laser, the pressure up of supply voltage becomes unnecessary and can solve the problem of power consumption and equipment size, and cost.
[0012]
[Means for Solving the Problem] The laser drive circuit of this invention consists of inductors connected with the current switch means which switches laser, the current regulator circuit which sets up the magnitude of the current which drives this laser, and the path of a current of connecting with a serial in this current regulator circuit, and flowing to this current regulator circuit in said current regulator circuit at the serial. Furthermore, it is about a laser drive circuit. 2 Even if as few as the current regulator circuit of an individual 2 The current switch means of an individual, At least 2 It constitutes from an inductor of an individual. The number of said current regulator circuit, The number of said current switch means and the number of said inductor spread a phase etc. The noninverting drive output of this current switch means is connected to the drive terminal of laser at juxtaposition. the inside of said current regulator circuit -- at least -- 2 the current which flows in a circuit -- a phase -- by controlling said current switch means to be equal and to carry out sequential supply of the drive current from this current regulator circuit at laser The period when the drive current to laser is made to supply by turns one by one from each inductor at, and a specific inductor supplies a drive current to laser is shortened.
[0013] Moreover, a high-frequency-current generating means to generate the frequency which reduces the return light noise of laser, The inductor which is connected to the output of this high-frequency-current generating means, exceeds the output voltage, and generates the pulse-like electrical potential difference of said frequency, Current which flows to this inductor 1 It has a rectification means to restrict to a direction, and by adding the current which flows this inductor to said laser drive current, the high frequency current of sufficient amplitude for the drive current of laser is superimposed, and a return light noise is oppressed.
[0014] Emission center wavelength by constituting a laser drive circuit including an inductor as above 680nm It is supply voltage about the following laser. 5V Said laser is driven below.
[0015] The invention in this application is especially suitable to record data with a precision sufficient on an optical recording medium combining the light pulse of multiple-value level. For this reason In the optical information record approach which records information on an optical recording medium by driving semiconductor laser using two or more channels located in a line with juxtaposition, and obtaining the laser beam output of a multiple value Each channel by having a current regulator circuit, the inductor by which a

series connection is carried out to a current regulator circuit, and the switching means which connects an inductor to semiconductor laser electrically, and controlling a switching means When a current is intermittently supplied to semiconductor laser and the current of the sum total from the inductor of each channel drives laser from the inductor of the arbitration of two or more channels, the laser beam output of a multiple value is obtained. Thus, the light pulse of output sufficient with supply voltage lower than before can be supplied with a low power.

[0016]

[Function] Generally it is an inductance. L It is a current to the inductor which it has. I It is time of day t about a sink and its current. When it is made to change with progress, in the both ends of the inductor, the electromotive force of the direction which bars change of a current arises in the magnitude of L|dI/dt|. Therefore, when a load is connected to an inductor and a serial, if the magnitude of the load changes, electromotive force will arise in an inductor, and it operates so that change, the current, i.e., the load current, which flows to the inductor itself, may be made into the minimum. That is, when a load becomes large, the energy stored in the interior of an inductor in the magnetic form is emitted as electrical energy, and it is going to suppress reduction of the current which flows an inductor and a load to the minimum.

[0017] Conversely, when a load becomes small, electric energy is changed into a magnetic form, and it stores in the interior of an inductor, and operates to suppress the increment in the current which flows an inductor and a load to the minimum. The period which can maintain a current and an electrical potential difference is determined by the magnitude of the inductance of an inductor, and this maintenance time amount also becomes long, so that an inductance is large. However, the time amount for storing energy in this and coincidence at an inductor also becomes long. Moreover, in order to make stability the current supplied by the inductor, it is necessary to conserve always sufficient energy for an inductor. That is, for that, the period which emits energy from an inductor must fully be shorter than the period which stores energy in an inductor.

[0018] on the other hand -- drawing 8 Current Miller circuit for the conventional laser drive circuit as shown to set up the magnitude of a drive current 105a a laser drive current -- receiving -- current Miller circuit 105a Current switch which controls addition of a current 103 from -- it has become. Laser diode 101 Since the forward voltage drop will become large if a drive current is made to increase, it is laser diode. 101 A drive current cannot be reaching the ceiling in that the sum of a forward voltage drop and the voltage drop by the drive circuit becomes equal to supply voltage, and a drive current cannot be increased more than it. That is, the maximum of a laser drive current is restricted by supply voltage in the conventional laser drive circuit.

[0019] Then, drawing 5 It is laser diode like. 101 Current regulator circuit which sets up the amplitude of the pulse current to drive 502 It is an inductor to a serial. 104 The case where it inserts is considered. Inductor 104 Internal resistance shall fully be low and shall be disregarded. In this case, the voltage drop and laser diode by the drive circuit 101 In the range of a drive current with the sum of a forward voltage drop lower than supply voltage, a drive circuit operates as usual. That is, it is usually a current switch means. 501 Load for balance 102 It has switched to the side and is a current regulator circuit. 502 It is an inductor by the programmed current. 104 It is an inductor while conserving energy. 104 The magnitude of the current which should be held is set up.

[0020] Laser diode 101 When passing a current, it is a current switch means. 501 Laser diode 101 It switches to a side and is a current regulator circuit. 502 And inductor The current which flows 104 turns into a laser drive current. A voltage drop and laser diode increase a drive current and according to a drive circuit 101 When the sum of a forward voltage drop approaches the value of supply voltage, it is a current regulator circuit. 502 Actuation becomes difficult and it is an inductor. 104 The flowing current decreases slightly.

[0021] However, the electromotive force of the direction which maintains a current value as mentioned above is an inductor to coincidence. Since it is generated in 104, effectiveness equivalent to the case where supply voltage rises effectually is acquired. Namely, inductor 104 By emitting the energy currently conserved, it becomes possible to supply a laser drive current temporarily.

[0022] Or drawing 6 It is an inductor so that it may be shown. 104 It is a current regulator circuit about the flowing current. 502 and laser diode 101 The case where it switches in between is considered. Usually, current switch means 501 Current regulator circuit 502 It has switched to the side and is an inductor by the programmed current. 104 The magnitude of the current which should be held while conserving energy is set up. Laser diode 101 When passing a current, it is a current switch means. 501 is laser diode. 101 It switches to a side. Current regulator circuit 502 It is laser diode from the voltage drop to depend. 101 The electromotive force of the direction which maintains a current value as mentioned above even when the

forward voltage drop is larger is an inductor. 104 Since it is generated, effectiveness equivalent to the case where supply voltage rises effectually is acquired. Namely, inductor 104 By emitting the energy currently conserved, it becomes possible to supply a laser drive current temporarily.

[0023] however, the above-mentioned passage -- inductor 104 in order to conserve always sufficient energy and to stabilize the amplitude of a laser drive current -- inductor 104 the period which conserves energy -- inductor 104 from -- it must fully be longer than the period to which energy is made to emit. Namely, current switch means 501 Drawing 5 It sets and is a load for balance. 102 The period which has switched to the side, or drawing 6 It sets and is a current regulator circuit. The period which has switched to 502 sides is a current switch means. 501 Laser diode 101 It must fully be longer than the period which has switched to the side.

[0024] then, drawing 5 Or drawing 6 Current regulator circuit shown 502 and inductor 104 And current switch means 501 from -- the drive output of the minimum configuration unit (in this invention, this will be called a "channel") of the becoming drive circuit -- juxtaposition -- connecting -- two or more channels of them 108 The current amplitude is set up equally. if it carries out like this -- laser diode the drive current of 101 -- each channel 108 from -- making it supply by turns one by one -- one channel 108 Laser diode 101 the period which supplies a drive current -- being shortened -- inductor 104 It becomes possible to conserve always sufficient energy.

[0025] Moreover, drawing 7 It is a high frequency pulse generating means so that it may be shown. 402 Switching means opened and closed by it 701 Inductor 104 And current regulator circuit 502 The case where a load is changed intermittently is considered. High frequency pulse generating means 402 The frequency suitable for forming the longitudinal mode of semiconductor laser into multi-mode, and reducing a return light noise shall be generated. switching means 701 changing from a closed state to an open condition -- following -- inductor 104 **** -- laser diode 101 The pulse voltage of the direction to which a drive current is made to increase occurs. Then, inductor 104 It is diode about the flowing current. 401 It rectifies and adds to a laser drive current. By this configuration, it is an inductor. 104 It is an inductor 104 when the time amount rate of change of the flowing current becomes beyond a predetermined value. Since the amplitude of the pulse voltage to generate also becomes large enough, it is laser diode 101. Even when a forward voltage drop is large, it becomes possible to superimpose the high frequency current of sufficient amplitude for a laser drive current.

[0026]

[Example] Drawing 1 Laser drive circuit in this invention 1 The circuit example of ** is shown. this example 1 a channel -- load for balance 102 Laser diode 101 Current switch which distributes a current in between 103 current switch 103 it connects with a serial -- having -- laser diode 101 Current Miller circuit which receives and sets up the current amplitude to supply 105a Current Miller circuit 105a Inductor inserted in a serial 104 It is constituted. from -- as a whole -- 4 Channel 108a-108d from -- it is constituted.

[0027] Each current switch 103 Addition control signal from a record wave generating circuit 106 It is controlled and is current Miller circuit. 105a And inductor 104 Laser diode 101 Load for balance 102 It switches with which it connects. it becomes the sum of the drive current by laser diode . 101 Load for balance 102 **** -- each channel 108a-108d Noninverting drive output 109a, Reversal drive output 109b it connects with juxtaposition, respectively -- having -- **** -- laser diode 101 And load for balance 102 the flowing current -- each channel 108a-108d Therefore, it is possible to drive laser diode 101 on multiple-value level.

[0028] Drawing 1 Each channel 108a-108d It is usually a current switch. 103 Load side for balance 102 Switch, and it is (for the transistor by the side of reversal, ON and the transistor by the side of noninverting are an OFF state), and is an inductor. 104 It is an inductor while conserving energy. The channel is laser diode by passing constant current to 104. The magnitude of the current supplied to 101 is set up.

[0029] Laser diode 101 It is a current switch when passing a current. 103 Laser diode 101 It switches to a side (for the transistor by the side of reversal, OFF and the transistor by the side of noninverting are an ON state), and is an inductor. 104 And current Miller circuit 105a Laser diode 101 A drive current is supplied. The voltage drop and laser diode by the drive circuit 101 In the range of a laser drive current in which the sum of a forward voltage drop becomes lower than supply voltage, a drive circuit operates as usual. The voltage drop and laser diode by the drive circuit 101 When the amplitude of a drive current is increased until the sum of a forward voltage drop became equal to supply voltage, it is current Miller circuit. 105a Actuation becomes difficult and it is an inductor. 104 The flowing current decreases slightly.

[0030] However, the electromotive force of the direction which maintains a current value at this time as the term of an operation explained is an inductor. 104 It is generated and effectiveness equivalent to

supply voltage having risen effectually is acquired. Namely, inductor 104 By emitting the energy currently conserved, it becomes possible to maintain a laser drive current temporarily.
[0031] Next, drawing 2 Other examples of the laser drive circuit in this invention are shown. 1 of this example Current Miller circuit where a channel sets up the amplitude of a drive current 105a current switch 103 Inductor connected to the collector side at the serial 104 inductor 104 the flowing current -- current Miller circuit 105a Laser diode 101 Current switch distributed in between 103 from -- it constitutes -- having -- **** -- as a whole -- 4 Channel 108a-108d from -- it is constituted.
[0032] Each current switch 103 Addition control signal from a record wave generating circuit 106 It is controlled and is an inductor. 104 It is current Miller circuit about the flowing current. 105a Laser diode 101 It switches into which it slushes. laser diode 101 **** -- each channel 108a-108d Noninverting drive output 109a it connects with juxtaposition -- having -- **** -- laser diode 101 a drive current -- each channel 108a-108d It becomes the sum of the drive current to depend.
[0033] Drawing 2 Each channel 108a-108d It is usually a current switch. 103 Current Miller circuit side 105a Switch, and it is (for the transistor by the side of reversal, ON and the transistor by the side of noninverting are an OFF state), and is an inductor. 104 It is an inductor while conserving energy. 104 The amplitude of the drive current of the channel is set up by passing constant current. Laser diode 101 It is a current switch when passing a current. 103 Laser diode 101 It switches to a side (for the transistor by the side of reversal, OFF and the transistor by the side of noninverting are an ON state), and is an inductor. 104 The flowing current is laser diode. 101 It is added to a drive current. Current Miller circuit 105a It is laser diode from a voltage drop. 101 It is an inductor as the term of an operation explained, even when the forward voltage drop was larger. 104 The electromotive force of the direction which maintains the flowing current value is an inductor. 104 It is generated and effectiveness equivalent to supply voltage having risen effectually is acquired. Namely, inductor 104 By emitting the energy currently conserved, it becomes possible to maintain a laser drive current temporarily.
[0034] Drawing 3 Drawing 1 Or drawing 2 Laser drive current in the case of performing record control using a drive circuit 302 A wave-like example and addition control signal corresponding to this 303a-303d An example is shown.
[0035] Drawing 1 Or drawing 2 Channel 3 108c And channel 4 108d It is current Miller circuit so that the drive current of the equal amplitude can be supplied. 105a The operating current is set up. Channel 3 108c And channel 4 108d Current switch 103 is laser diode. 101 So that it may receive and a drive current may be supplied by turns one by one Channel 3, Channel 4 Addition control signal 303c and 303d It is controlled. It secures for a long time than the period which switches to a current switch side, and emits energy from inductor 104 by a series of above actuation, and is an inductor. 103 Reversal drive output 109b It switches to a side and is an inductor. 104 About the period which conserves energy, it is a current switch. 103 Noninverting drive output 109a It becomes possible to conserve sufficient energy for 104 and to supply a drive current to stability.
[0036] At this invention, it is emission center wavelength as a source of short wave Nagamitsu. Laser diode shorter than 680nm or it 5V It assumes driving according to the power source of the following electrical potential differences. 680nm band laser diode -- numerical aperture 0.55 the usual record playback specified from the size of an optical spot when it combines with an objective lens -- the limitation of resolution -- abbreviation 0.41 micrometers It becomes and, generally, as for the diameter of the record mark used for record under these optical conditions, this value serves as a minimum. It is linear velocity about this minimum record mark. 19 m/s Laser diode is an optical output when forming on an optical magnetic medium. 25mW, Period 11ns It drives so that pulse luminescence of extent may be performed.
[0037] drawing 10 according to the drive property of laser diode which showed the property -- laser forward current at this time IF 1001 Abbreviation 80mA and electrical potential difference between anode cathodes VF 1002 Abbreviation 2.3V it is -- since -- record mark 1 in order to carry out individual formation -- abbreviation 2microJ Electrical energy will call it the need.
[0038] in this case, drawing 8 Collector to emitter voltage of the transistor which constitutes a channel in the conventional laser drive circuit as shown Resistance inserted in the emitter of the output transistor of 0.6V and current Miller circuit at the serial 20 ohms ** -- the voltage drop by the channel if it carries out -- max -- abbreviation 2.8V It becomes. Therefore, the sum of the voltage drop by laser diode and the voltage drop by the drive circuit is abbreviation at the maximum. 5.1V It becomes and is an electrical potential difference. 5V The drive by the power source becomes impossible. On the other hand, the energy currently stored in the inductor is the inductance of an inductor. L, Flowing current I Then, LI(1/2)^2 It is expressed. (Operator with which "^" expresses a exponentiation) above -- 1 Energy required in order to form the record mark of an individual 1 a channel -- namely, -- 1 supposing it supplies from the inductor of

an individual -- from this L Magnitude is restricted. LI^2 > 2 [namely, (1/2),] (muJ) -- if size relation needs to be satisfied and this is solved -- 0.63 (microhenry) < L is obtained. Therefore, it sets to this invention and is about the inductance of each inductor. 1 microhenry Carrying out to more than extent is desirable. Sufficient energy for an inductor cannot be conserved as it is less than [this], and laser may fully be unable to be driven.

[0039] Drawing 4 Other examples of the laser drive circuit in this invention are shown. At this example, it is a high frequency pulse generating means. 402 Field effect transistor opened and closed 402 Current Miller circuit 105b Inductor 104 It connects with a serial and is current Miller circuit. 105b And inductor 104 It has the composition of changing a load intermittently. High frequency pulse generating means 402 The frequency suitable for forming the longitudinal mode of semiconductor laser into multi-mode, and reducing a return light noise shall be generated. field effect transistor 403 at the same time it changes from ON to OFF -- inductor 104 **** -- laser diode 101 the pulse voltage of the direction which slushes a current -- generating -- diode 401 minding -- inductor 104 The flowing current is added to a laser drive current. Inductor 104 It is an inductor when the time amount rate of change of the flowing current becomes beyond a predetermined value. 104 Since the amplitude of the pulse voltage to generate also becomes large enough, it is laser diode. 101 A forward voltage drop is large, and even when the output voltage amplitude runs short, it becomes possible to superimpose the high frequency current of sufficient amplitude for a laser drive current in the conventional usual RF superposition circuit.

[0040]

[Effect of the Invention] According to this invention, compared with the former, the laser drive circuit which can operate with lower supply voltage is realizable. Thereby, also when a laser forward voltage drop is expanded with short-wavelength-izing of semiconductor laser, it becomes unnecessary to prepare the pressure-up means of supply voltage, and low-power-izing and miniaturization of equipment, and reduction of cost can be enabled.

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TECHNICAL FIELD

[Industrial Application] This invention relates to the drive circuit of laser.

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PRIOR ART

[Description of the Prior Art] An optical disk has the description that storing of extensive information is possible and exchange of a medium is possible, and is spreading quickly [current]. It is common to the light source of this optical disk to use the semiconductor laser diode of a vertical single mode. However, when the light from the outside returns in the resonator of semiconductor laser, semiconductor laser causes fluctuation of the luminescence reinforcement called a return light noise. Since this return light noise reduces the quality of a regenerative signal, when attaining densification, it poses a problem.
[0003] in order [then,] to solve this problem -- Japan public presentation patent public-relations: -- Showa 56-37834 etc. -- well-known -- as -- a laser drive current -- several 10- hundreds MHz By superimposing the high frequency current, the longitudinal mode of laser is formed into multi-mode and the technique of reducing the coherence of a laser beam and reducing a return light noise is known. With this conventional technique, the source of a direct current and the source of RF alternating current are connected to laser at coincidence, and the configuration which superimposes the high frequency current on a laser drive current is taken. For this reason, the maximum of a laser drive current is restricted with the supply voltage of the source of a direct current, and the source of RF alternating current.
[0004] Moreover, the magneto-optic disk and phase change mold disk which are a kind of an optical disk narrow down the light from a laser light source, heat a record medium locally, and are recording information by forming a record mark. In these optical disk units, it is required for coincidence to control a mark configuration correctly, reducing a record mark, in order to aim at improvement in recording density, maintaining the dependability of recording information. this purpose -- Japan public presentation patent public-relations: -- Taira 5-298737 etc. -- the record control technique which forms a record mark in a precision by the light pulse with two or more sound power levels is developed so that it may be well-known.
[0005] It is drawing about the example of a configuration of the laser drive circuit in the case of performing record control. 8 Drawing 8 It is drawing about the corresponding example of a laser drive current wave form and a laser drive circuit of operation. 9 It is shown. this configuration 3 Current Miller circuit of a network 105a Current switch 103 minding -- juxtaposition -- connecting -- addition control signal from a record wave control circuit 106 Follow and add each current suitably. 4 Gradual laser drive current 302 namely, -- 4 Gradual luminescence level on the strength is generated.
[0006] the case of this circuitry -- laser diode 101 **** -- current switch 103 Current Miller circuit 105a It is inserted in a serial and a voltage drop arises by the circuit element which constitutes these. For this reason, laser diode 101 In order to drive by the luminescence reinforcement of arbitration, the supply voltage of the more than which applied the voltage drop by the drive circuit was required for the maximum electrical potential difference between laser drive terminals.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, compared with the former, the laser drive circuit which can operate with lower supply voltage is realizable. Thereby, also when a laser forward voltage drop is expanded with short-wavelength-izing of semiconductor laser, it becomes unnecessary to prepare the pressure-up means of supply voltage, and low-power-izing and miniaturization of equipment, and reduction of cost can be enabled.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In order to raise the recording density of an optical disk, it is most direct to reduce the path of the optical spot which shortens the wavelength of the laser light source to be used and is used for record playback, and it is effective. Short wavelength-ization of the semiconductor laser diode generally used as the current light source is performed by changing the ingredient of a component and expanding a band gap. However, it has been hard and become to fully raise carrier concentration as a band gap is expanded, and the resistivity of the ingredient itself has been increasing by this. For this reason, for future semiconductor laser diode, it is likely to expand to high-priced [this] by modification of the component ingredient accompanying short-wavelength-izing.
[0008] Moreover, it is necessary with large-capacity-izing by improvement in recording density to also accelerate the rate of record playback. For this reason, more nearly high-speed actuation is demanded also of the circuit element which performs signal processing. The semiconductor device which generally performs high-speed operation operates with supply voltage lower than before in many cases. Moreover, there is an inclination to reduce supply voltage to this and coincidence for the purpose of low-power-izing of equipment itself. current -- as a power source +5V +12V -- or -- although the equipment which operates in response to supply of only +5V is common -- the future -- these +5V Becoming the following single power supplies is expected.
[0009] When optical-magnetic disc equipment performs record by the light modulation method, the semiconductor laser of the light source is driven by the pulse current of the large amplitude, and generates the light pulse of high luminescence level on the strength by short width of face. It is drawing about an example of the laser drive circuit of the conventional magneto-optic disk. 8 It is drawing about the example of operation. 9 It is shown. Moreover, it is drawing about an example of the drive property of semiconductor laser. 10 It is shown. Luminescence reinforcement IOUT 1003 For raising, it is forward current of laser. IF 1001 It becomes large and is an electrical potential difference between anode cathodes. VF 1002 Since it expands, the upper limit decided by supply voltage exists in a laser drive current. That is, it is impossible to drive laser with the power source of an electrical potential difference lower than the sum of the voltage drop of a laser drive circuit and a laser forward voltage drop.
[0010] In order to solve these problems, the pressure up of the power source of a low electrical potential difference is carried out, and a high electrical potential difference is obtained continuously. DC-DC There is a means of a converter etc. However, it is DC-DC only because of a laser drive circuit. It is disadvantageous to prepare a converter in respect of the miniaturization of equipment, and cost.
[0011] So, in this invention, by combining an inductor with a laser drive circuit, these problems are solved and the limit to the supply voltage by the laser forward voltage drop is eased. Thereby, since the drive of the laser in supply voltage lower than before is possible even when the forward voltage drop of laser goes up with short-wavelength-izing of semiconductor laser, the pressure up of supply voltage becomes unnecessary and can solve the problem of power consumption and equipment size, and cost.

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MEANS

[Means for Solving the Problem] The laser drive circuit of this invention consists of inductors connected with the current switch means which switches laser, the current regulator circuit which sets up the magnitude of the current which drives this laser, and the path of a current of connecting with a serial in this current regulator circuit, and flowing to this current regulator circuit in said current regulator circuit at the serial. Furthermore, it is about a laser drive circuit. 2 Even if as few as the current regulator circuit of an individual 2 The current switch means of an individual, At least 2 It constitutes from an inductor of an individual. The number of said current regulator circuit, The number of said current switch means and the number of said inductor spread a phase etc. The noninverting drive output of this current switch means is connected to the drive terminal of laser at juxtaposition. the inside of said current regulator circuit -- at least -- 2 the current which flows in a circuit -- a phase -- by controlling said current switch means to be equal and to carry out sequential supply of the drive current from this current regulator circuit at laser The period when the drive current to laser is made to supply by turns one by one from each inductor at, and a specific inductor supplies a drive current to laser is shortened.
[0013] Moreover, a high-frequency-current generating means to generate the frequency which reduces the return light noise of laser, The inductor which is connected to the output of this high-frequency-current generating means, exceeds the output voltage, and generates the pulse-like electrical potential difference of said frequency, Current which flows to this inductor 1 It has a rectification means to restrict to a direction, and by adding the current which flows this inductor to said laser drive current, the high frequency current of sufficient amplitude for the drive current of laser is superimposed, and a return light noise is oppressed.
[0014] Emission center wavelength by constituting a laser drive circuit including an inductor as above 680nm It is supply voltage about the following laser. 5V Said laser is driven below.
[0015] The invention in this application is especially suitable to record data with a precision sufficient on an optical recording medium combining the light pulse of multiple-value level. For this reason In the optical information record approach which records information on an optical recording medium by driving semiconductor laser using two or more channels located in a line with juxtaposition, and obtaining the laser beam output of a multiple value Each channel by having a current regulator circuit, the inductor by which a series connection is carried out to a current regulator circuit, and the switching means which connects an inductor to semiconductor laser electrically, and controlling a switching means When a current is intermittently supplied to semiconductor laser and the current of the sum total from the inductor of each channel drives laser from the inductor of the arbitration of two or more channels, the laser beam output of a multiple value is obtained. Thus, the light pulse of output sufficient with supply voltage lower than before can be supplied with a low power.

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OPERATION

[Function] Generally it is an inductance. L It is a current to the inductor which it has. I It is time of day t about a sink and its current. When it is made to change with progress, in the both ends of the inductor, the electromotive force of the direction which bars change of a current arises in the magnitude of L|dI/dt|. Therefore, when a load is connected to an inductor and a serial, if the magnitude of the load changes, electromotive force will arise in an inductor, and it operates so that change, the current, i.e., the load current, which flows to the inductor itself, may be made into the minimum. That is, when a load becomes large, the energy stored in the interior of an inductor in the magnetic form is emitted as electrical energy, and it is going to suppress reduction of the current which flows an inductor and a load to the minimum.
[0017] Conversely, when a load becomes small, electric energy is changed into a magnetic form, and it stores in the interior of an inductor, and operates to suppress the increment in the current which flows an inductor and a load to the minimum. The period which can maintain a current and an electrical potential difference is determined by the magnitude of the inductance of an inductor, and this maintenance time amount also becomes long, so that an inductance is large. However, the time amount for storing energy in this and coincidence at an inductor also becomes long. Moreover, in order to make stability the current supplied by the inductor, it is necessary to conserve always sufficient energy for an inductor. That is, for that, the period which emits energy from an inductor must fully be shorter than the period which stores energy in an inductor.
[0018] on the other hand -- drawing 8 Current Miller circuit for the conventional laser drive circuit as shown to set up the magnitude of a drive current 105a a laser drive current -- receiving -- current Miller circuit 105a Current switch which controls addition of a current 103 from -- it has become. Laser diode 101 Since the forward voltage drop will become large if a drive current is made to increase, it is laser diode. 101 A drive current cannot be reaching the ceiling in that the sum of a forward voltage drop and the voltage drop by the drive circuit becomes equal to supply voltage, and a drive current cannot be increased more than it. That is, the maximum of a laser drive current is restricted by supply voltage in the conventional laser drive circuit.
[0019] Then, drawing 5 It is laser diode like. 101 Current regulator circuit which sets up the amplitude of the pulse current to drive 502 It is an inductor to a serial. 104 The case where it inserts is considered. Inductor 104 Internal resistance shall fully be low and shall be disregarded. In this case, the voltage drop and laser diode by the drive circuit 101 In the range of a drive current with the sum of a forward voltage drop lower than supply voltage, a drive circuit operates as usual. That is, it is usually a current switch means. 501 Load for balance 102 It has switched to the side and is a current regulator circuit. 502 It is an inductor by the programmed current. 104 It is an inductor while conserving energy. 104 The magnitude of the current which should be held is set up.
[0020] Laser diode 101 When passing a current, it is a current switch means. 501 Laser diode 101 It switches to a side and is a current regulator circuit. 502 And inductor The current which flows 104 turns into a laser drive current. A voltage drop and laser diode increase a drive current and according to a drive circuit 101 When the sum of a forward voltage drop approaches the value of supply voltage, it is a current regulator circuit. 502 Actuation becomes difficult and it is an inductor. 104 The flowing current decreases slightly.
[0021] However, the electromotive force of the direction which maintains a current value as mentioned above is an inductor to coincidence. Since it is generated in 104, effectiveness equivalent to the case where supply voltage rises effectually is acquired. Namely, inductor 104 By emitting the energy currently conserved, it becomes possible to supply a laser drive current temporarily.
[0022] Or drawing 6 It is an inductor so that it may be shown. 104 It is a current regulator circuit about the

flowing current. 502 and laser diode 101 The case where it switches in between is considered. Usually, current switch means 501 Current regulator circuit 502 It has switched to the side and is an inductor by the programmed current. 104 The magnitude of the current which should be held while conserving energy is set up. Laser diode 101 When passing a current, it is a current switch means. 501 is laser diode. 101 It switches to a side. Current regulator circuit 502 It is laser diode from the voltage drop to depend. 101 The electromotive force of the direction which maintains a current value as mentioned above even when the forward voltage drop is larger is an inductor. 104 Since it is generated, effectiveness equivalent to the case where supply voltage rises effectually is acquired. Namely, inductor 104 By emitting the energy currently conserved, it becomes possible to supply a laser drive current temporarily.

[0023] however, the above-mentioned passage -- inductor 104 in order to conserve always sufficient energy and to stabilize the amplitude of a laser drive current -- inductor 104 the period which conserves energy -- inductor 104 from -- it must fully be longer than the period to which energy is made to emit. Namely, current switch means 501 Drawing 5 It sets and is a load for balance. 102 The period which has switched to the side, or drawing 6 It sets and is a current regulator circuit. The period which has switched to 502 sides is a current switch means. 501 Laser diode 101 It must fully be longer than the period which has switched to the side.

[0024] then, drawing 5 Or drawing 6 Current regulator circuit shown 502 and inductor 104 And current switch means 501 from -- the drive output of the minimum configuration unit (in this invention, this will be called a "channel") of the becoming drive circuit -- juxtaposition -- connecting -- two or more channels of them 108 The current amplitude is set up equally. if it carries out like this -- laser diode the drive current of 101 -- each channel 108 from -- making it supply by turns one by one -- one channel 108 Laser diode 101 the period which supplies a drive current -- being shortened -- inductor 104 It becomes possible to conserve always sufficient energy.

[0025] Moreover, drawing 7 It is a high frequency pulse generating means so that it may be shown. 402 Switching means opened and closed by it 701 Inductor 104 And current regulator circuit 502 The case where a load is changed intermittently is considered. High frequency pulse generating means 402 The frequency suitable for forming the longitudinal mode of semiconductor laser into multi-mode, and reducing a return light noise shall be generated. switching means 701 changing from a closed state to an open condition -- following -- inductor 104 **** -- laser diode 101 The pulse voltage of the direction to which a drive current is made to increase occurs. Then, inductor 104 It is diode about the flowing current. 401 It rectifies and adds to a laser drive current. By this configuration, it is an inductor. 104 It is an inductor 104 when the time amount rate of change of the flowing current becomes beyond a predetermined value. Since the amplitude of the pulse voltage to generate also becomes large enough, it is laser diode 101. Even when a forward voltage drop is large, it becomes possible to superimpose the high frequency current of sufficient amplitude for a laser drive current.

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EXAMPLE

[Example] Drawing 1 Laser drive circuit in this invention 1 The circuit example of ** is shown. this example 1 a channel -- load for balance 102 Laser diode 101 Current switch which distributes a current in between 103 current switch 103 it connects with a serial -- having -- laser diode 101 Current Miller circuit which receives and sets up the current amplitude to supply 105a Current Miller circuit 105a Inductor inserted in a serial 104 It is constituted. from -- as a whole -- 4 Channel 108a-108d from -- it is constituted.
[0027] Each current switch 103 Addition control signal from a record wave generating circuit 106 It is controlled and is current Miller circuit. 105a And inductor 104 Laser diode 101 Load for balance 102 It switches with which it connects. it becomes the sum of the drive current by laser diode . 101 Load for balance 102 **** -- each channel 108a-108d Noninverting drive output 109a, Reversal drive output 109b it connects with juxtaposition, respectively -- having -- **** -- laser diode 101 And load for balance 102 the flowing current -- each channel 108a-108d Therefore, it is possible to drive laser diode 101 on multiple-value level.
[0028] Drawing 1 Each channel 108a-108d It is usually a current switch. 103 Load side for balance 102 Switch, and it is (for the transistor by the side of reversal, ON and the transistor by the side of noninverting are an OFF state), and is an inductor. 104 It is an inductor while conserving energy. The channel is laser diode by passing constant current to 104. The magnitude of the current supplied to 101 is set up.
[0029] Laser diode 101 It is a current switch when passing a current. 103 Laser diode 101 It switches to a side (for the transistor by the side of reversal, OFF and the transistor by the side of noninverting are an ON state), and is an inductor. 104 And current Miller circuit 105a Laser diode 101 A drive current is supplied. The voltage drop and laser diode by the drive circuit 101 In the range of a laser drive current in which the sum of a forward voltage drop becomes lower than supply voltage, a drive circuit operates as usual. The voltage drop and laser diode by the drive circuit 101 When the amplitude of a drive current is increased until the sum of a forward voltage drop became equal to supply voltage, it is current Miller circuit. 105a Actuation becomes difficult and it is an inductor. 104 The flowing current decreases slightly.
[0030] However, the electromotive force of the direction which maintains a current value at this time as the term of an operation explained is an inductor. 104 It is generated and effectiveness equivalent to supply voltage having risen effectually is acquired. Namely, inductor 104 By emitting the energy currently conserved, it becomes possible to maintain a laser drive current temporarily.
[0031] Next, drawing 2 Other examples of the laser drive circuit in this invention are shown. 1 of this example Current Miller circuit where a channel sets up the amplitude of a drive current 105a current switch 103 Inductor connected to the collector side at the serial 104 inductor 104 the flowing current -- current Miller circuit 105a Laser diode 101 Current switch distributed in between 103 from -- it constitutes -- having -- **** -- as a whole -- 4 Channel 108a-108d from -- it is constituted.
[0032] Each current switch 103 Addition control signal from a record wave generating circuit 106 It is controlled and is an inductor. 104 It is current Miller circuit about the flowing current. 105a Laser diode 101 It switches into which it slushes. laser diode 101 **** -- each channel 108a-108d Noninverting drive output 109a it connects with juxtaposition -- having -- **** -- laser diode 101 a drive current -- each channel 108a-108d It becomes the sum of the drive current to depend.
[0033] Drawing 2 Each channel 108a-108d It is usually a current switch. 103 Current Miller circuit side 105a Switch, and it is (for the transistor by the side of reversal, ON and the transistor by the side of noninverting are an OFF state), and is an inductor. 104 It is an inductor while conserving energy. 104 The amplitude of the drive current of the channel is set up by passing constant current. Laser diode 101 It is a current switch when passing a current. 103 Laser diode 101 It switches to a side (for the transistor by the

side of reversal, OFF and the transistor by the side of noninverting are an ON state), and is an inductor. 104 The flowing current is laser diode. 101 It is added to a drive current. Current Miller circuit 105a It is laser diode from a voltage drop. 101 It is an inductor as the term of an operation explained, even when the forward voltage drop was larger. 104 The electromotive force of the direction which maintains the flowing current value is an inductor. 104 It is generated and effectiveness equivalent to supply voltage having risen effectually is acquired. Namely, inductor 104 By emitting the energy currently conserved, it becomes possible to maintain a laser drive current temporarily.

[0034] Drawing 3 Drawing 1 Or drawing 2 Laser drive current in the case of performing record control using a drive circuit 302 A wave-like example and addition control signal corresponding to this 303a-303d An example is shown.

[0035] Drawing 1 Or drawing 2 Channel 3 108c And channel 4 108d It is current Miller circuit so that the drive current of the equal amplitude can be supplied. 105a The operating current is set up. Channel 3 108c And channel 4 108d Current switch 103 is laser diode. 101 So that it may receive and a drive current may be supplied by turns one by one Channel 3, Channel 4 Addition control signal 303c and 303d It is controlled. It secures for a long time than the period which switches to a current switch side, and emits energy from inductor 104 by a series of above actuation, and is an inductor. 103 Reversal drive output 109b It switches to a side and is an inductor. 104 About the period which conserves energy, it is a current switch. 103 Noninverting drive output 109a It becomes possible to conserve sufficient energy for 104, and to supply a drive current to stability.

[0036] At this invention, it is emission center wavelength as a source of short wave Nagamitsu. Laser diode shorter than 680nm or it 5V It assumes driving according to the power source of the following electrical potential differences. 680nm band laser diode -- numerical aperture 0.55 the usual record playback specified from the size of an optical spot when it combines with an objective lens -- the limitation of resolution -- abbreviation 0.41 micrometers It becomes and, generally, as for the diameter of the record mark used for record under these optical conditions, this value serves as a minimum. It is linear velocity about this minimum record mark. 19 m/s Laser diode is an optical output when forming on an optical magnetic medium. 25mW, Period 11ns It drives so that pulse luminescence of extent may be performed.

[0037] drawing 10 according to the drive property of laser diode which showed the property -- laser forward current at this time IF 1001 Abbreviation 80mA and electrical potential difference between anode cathodes VF 1002 Abbreviation 2.3V it is -- since -- record mark 1 in order to carry out individual formation -- abbreviation 2microJ Electrical energy will call it the need.

[0038] in this case, drawing 8 Collector to emitter voltage of the transistor which constitutes a channel in the conventional laser drive circuit as shown Resistance inserted in the emitter of the output transistor of 0.6V and current Miller circuit at the serial 20 ohms ** -- the voltage drop by the channel if it carries out -- max -- abbreviation 2.8V It becomes. Therefore, the sum of the voltage drop by laser diode and the voltage drop by the drive circuit is abbreviation at the maximum. 5.1V It becomes and is an electrical potential difference. 5V The drive by the power source becomes impossible. On the other hand, the energy currently stored in the inductor is the inductance of an inductor. L, Flowing current I Then, LI(1/2)^2 It is expressed. (Operator with which "^" expresses a exponentiation) above -- 1 Energy required in order to form the record mark of an individual 1 a channel -- namely, -- 1 supposing it supplies from the inductor of an individual -- from this L Magnitude is restricted. LI^2 > 2 [namely, (1/2),] (muJ) -- if size relation needs to be satisfied and this is solved -- 0.63 (microhenry) < L is obtained. Therefore, it sets to this invention and is about the inductance of each inductor. 1 microhenry Carrying out to more than extent is desirable. Sufficient energy for an inductor cannot be conserved as it is less than [this], and laser may fully be unable to be driven.

[0039] Drawing 4 Other examples of the laser drive circuit in this invention are shown. At this example, it is a high frequency pulse generating means. 402 Field effect transistor opened and closed 402 Current Miller circuit 105b Inductor 104 It connects with a serial and is current Miller circuit. 105b And inductor 104 It has the composition of changing a load intermittently. High frequency pulse generating means 402 The frequency suitable for forming the longitudinal mode of semiconductor laser into multi-mode, and reducing a return light noise shall be generated. field effect transistor 403 at the same time it changes from ON to OFF -- inductor 104 **** -- laser diode 101 the pulse voltage of the direction which slushes a current -- generating -- diode 401 minding -- inductor 104 The flowing current is added to a laser drive current. Inductor 104 It is an inductor when the time amount rate of change of the flowing current becomes beyond a predetermined value. 104 Since the amplitude of the pulse voltage to generate also becomes large enough, it is laser diode. 101 A forward voltage drop is large, and even when the output voltage amplitude runs short, it becomes possible to superimpose the high frequency current of sufficient amplitude for a

laser drive current in the conventional usual RF superposition circuit.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] ** of this invention 1 Circuit diagram explaining an example.
[Drawing 2] ** of this invention 2 Circuit diagram explaining an example.
[Drawing 3] ** of this invention 2 Wave form chart explaining the example of an example of operation.
[Drawing 4] ** of this invention 3 Circuit diagram explaining an example.
[Drawing 5] ** of this invention 1 Circuit diagram explaining the theoretic configuration of invention.
[Drawing 6] ** of this invention 2 Circuit diagram explaining the theoretic configuration of invention.
[Drawing 7] ** of this invention 3 Circuit diagram explaining the theoretic configuration of invention.
[Drawing 8] The circuit diagram explaining the example of a configuration of the conventional laser drive circuit corresponding to record control.
[Drawing 9] The wave form chart explaining the example of the conventional laser drive circuit corresponding to record control of operation.
[Drawing 10] The graphical representation explaining the example of the drive property of semiconductor laser.
[Description of Notations]
101 -- Laser diode, 102 -- The load for balance, 103 -- Current switch, 104 -- An inductor, 105a, 105b -- Current Miller circuit, 106 -- An addition control signal, 107 -- A current regulator circuit control signal, 108 -- Channel, 109a -- A noninverting drive output, 109b -- A reversal drive output, 109c -- Common output, 302 [-- A field effect transistor, 501 / -- A current switch means, 502 / -- A current regulator circuit, 701 / -- Switching means.] -- A laser drive current, 401 -- Diode, 402 -- A high frequency pulse generating means, 403

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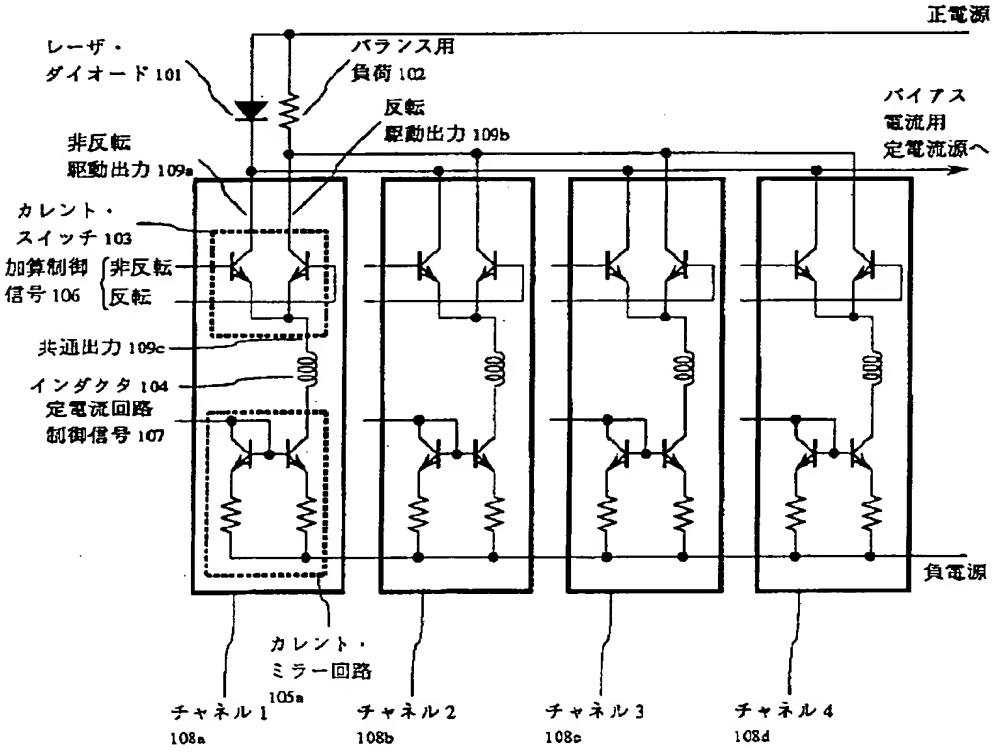
DRAWINGS

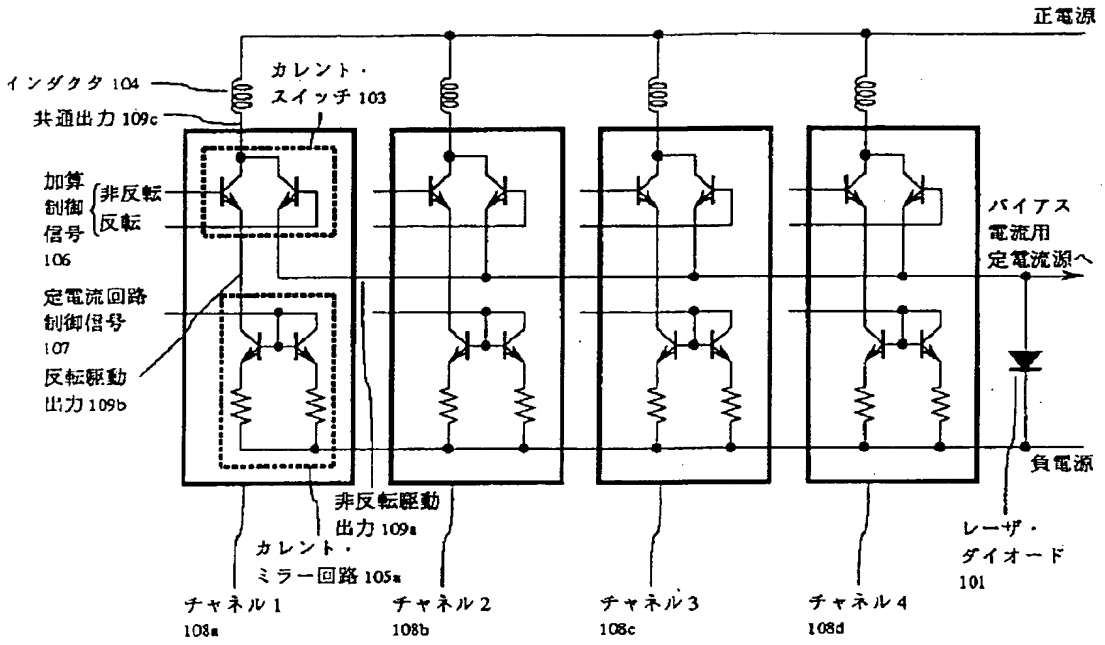
[Drawing 1]

図 1



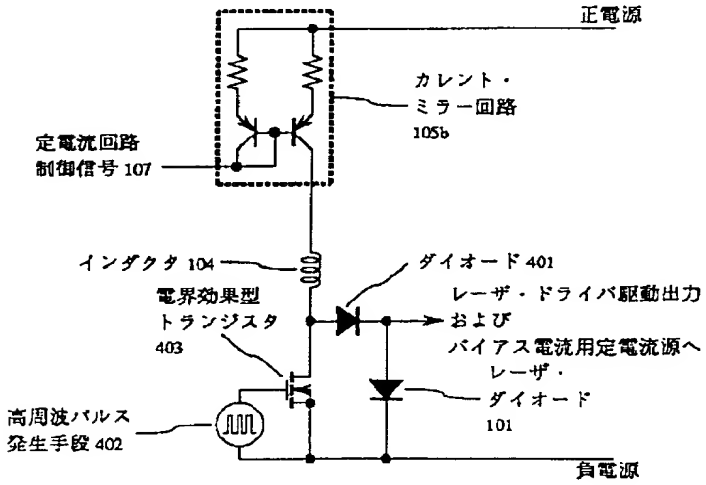
[Drawing 2]

図 2



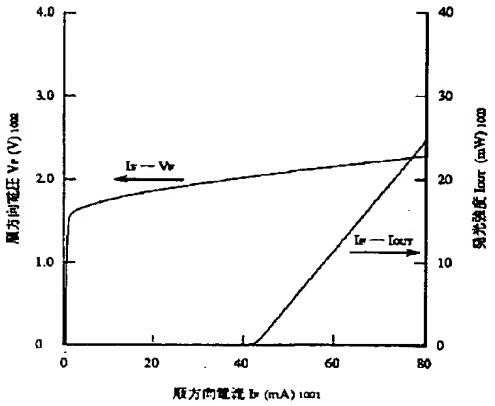
[Drawing 4]

図 4



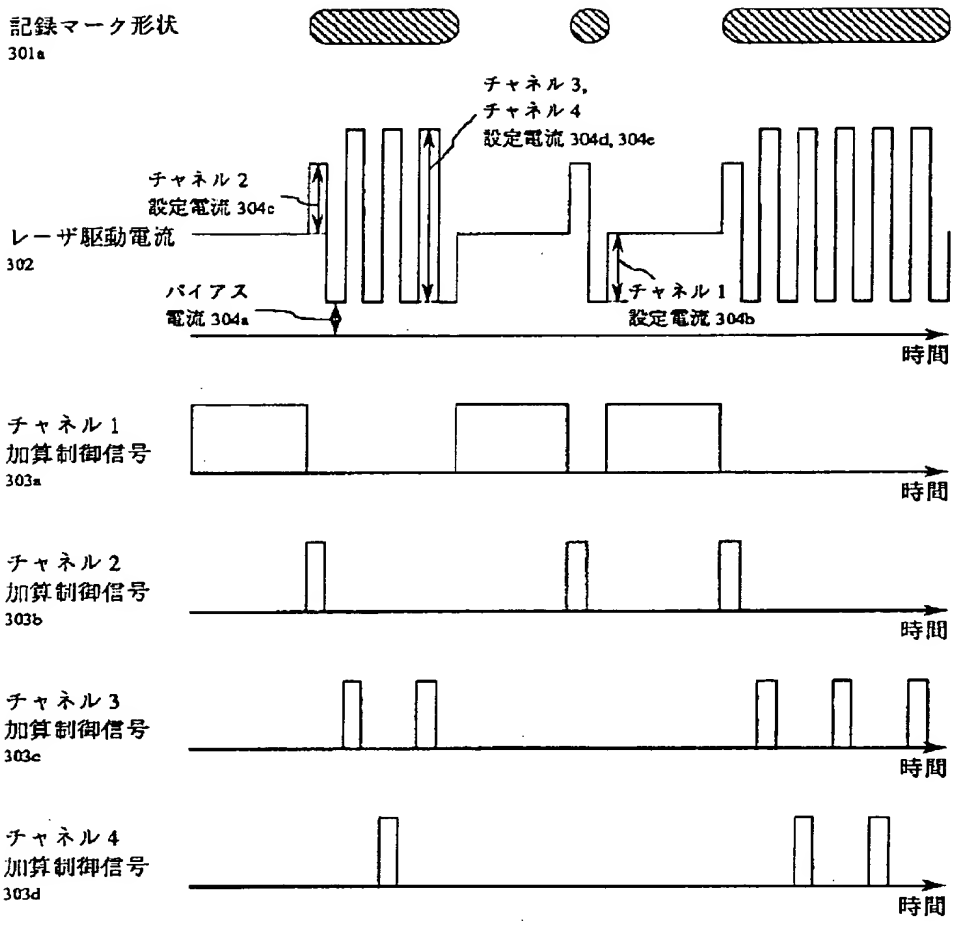
[Drawing 10]

図 10



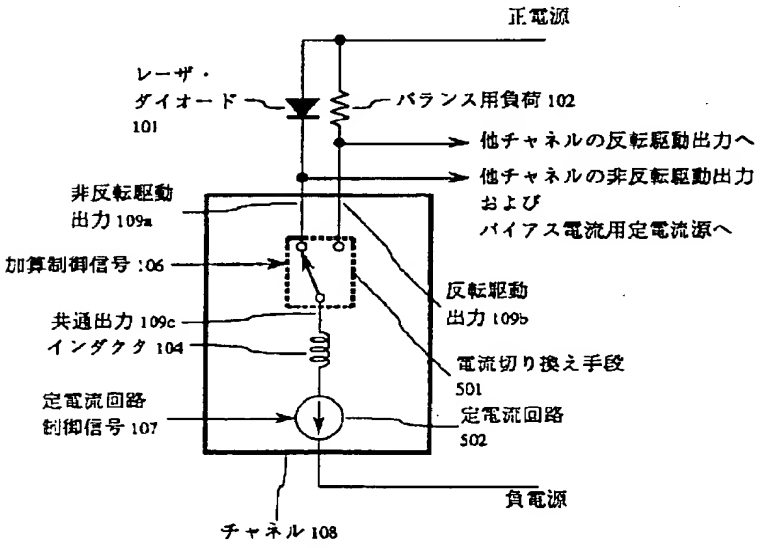
[Drawing 3]

図 3



[Drawing 5]

図 5



[Drawing 6]

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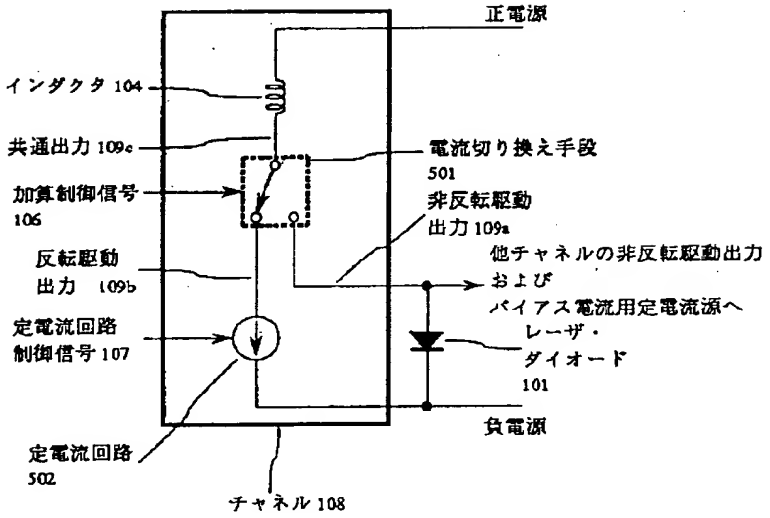
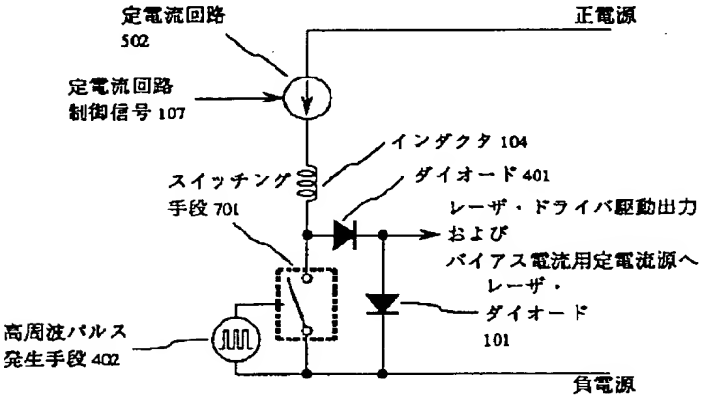


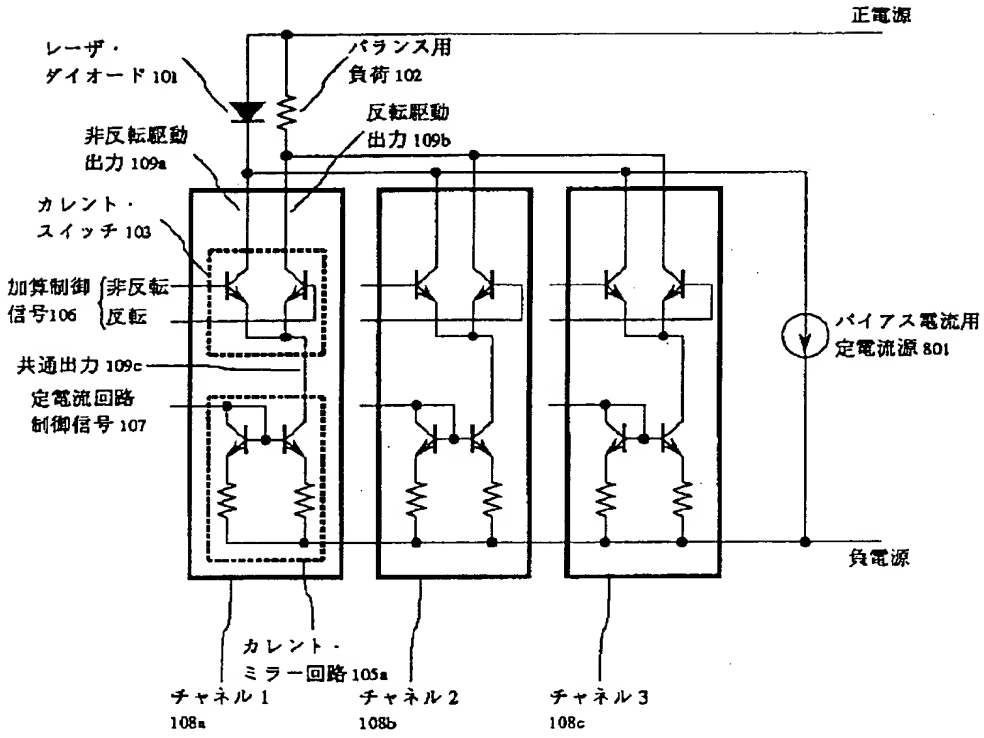
[Drawing 7]

図 7



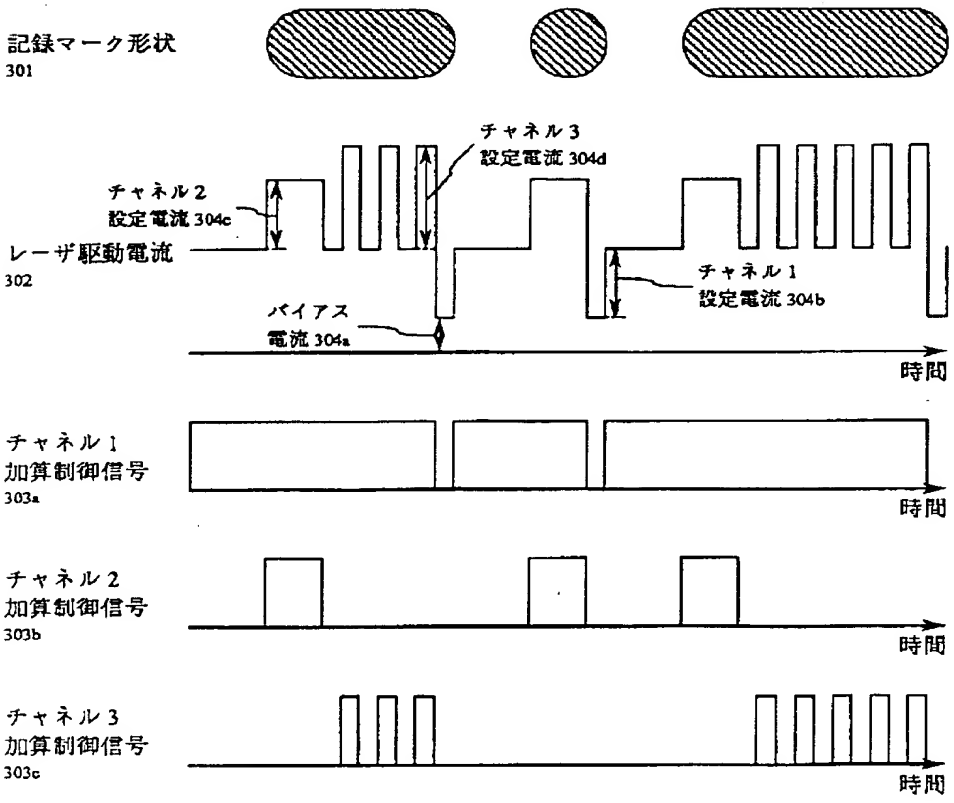
[Drawing 8]

図 8



[Drawing 9]

図 9



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(54)【発明の名称】　レーザ駆動回路

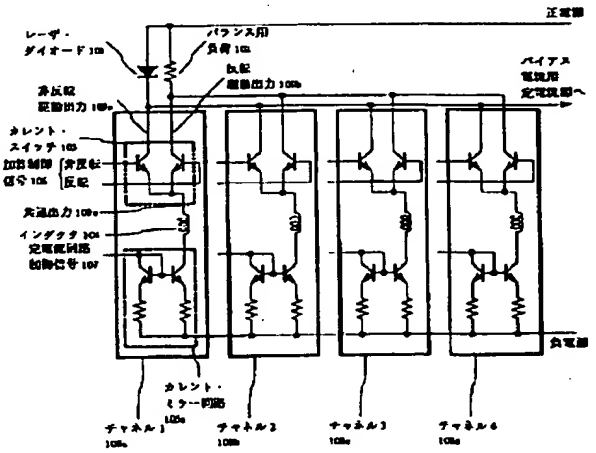
(57)【要約】

【目的】　従来よりも低い電源電圧でのレーザの駆動を可能とし、レーザ順方向電圧降下による電源電圧への制限を緩和する。

【構成】　レーザ駆動回路を、レーザ１０１と、定電流回路１０５と、定電流回路に直列に接続した電流切り換え手段１０３と、定電流回路に直列に接続したインダクタ１０４から構成する。あるいは高周波電流発生手段によってインダクタにパルス電流を流すことにより、インダクタにパルス電圧を発生させ、インダクタからの電流をレーザ駆動電流に加算する。

【効果】　レーザ駆動のための高い電圧の電源や特別な昇圧手段を準備する必要がなくなり、低消費電力化および装置の小型化とコストの低減を可能とする。

図１



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【特許請求の範囲】

【請求項１】発光中心波長が 680nm 以下のレーザと、インダクタから成り、電源電圧 5V以下で前記レーザを駆動することを特徴としたレーザ駆動回路。

【請求項２】レーザと、該レーザを駆動する電流の大きさを設定する定電流回路と、該定電流回路に直列に接続され該定電流回路に流れる電流の経路を切り換える電流切り換え手段と、前記定電流回路に直列に接続されたインダクタから成ることを特徴とするレーザ駆動回路。

【請求項３】レーザと、該レーザを駆動する電流の大きさを設定する定電流回路と、該定電流回路に直列に接続され該定電流回路に流れる電流の経路を切り換える電流切り換え手段と、前記定電流回路に直列に接続されたインダクタから成ることを特徴とする請求項 1 記載のレーザ駆動回路。

【請求項４】前記電流切り換え手段の共通出力に前記インダクタと前記定電流回路が直列に接続され、前記各電流切り換え手段の非反転駆動出力がレーザの駆動端子に接続されることを特長とする請求項２または３記載のレーザ駆動回路。

【請求項５】前記電流切り換え手段の共通出力にインダクタが接続され、該電流切り換え手段の反転駆動出力が定電流回路に接続され、該電流切り換え手段の非反転駆動出力がレーザの駆動端子に接続されることを特徴とした請求項２または３記載のレーザ駆動回路。

【請求項６】少なくとも 2 個の定電流回路と、少なくとも 2 個の電流切り換え手段と、少なくとも 2 個のインダクタを有し、前記定電流回路の個数と、前記電流切り換え手段の個数と、前記インダクタの個数が相等しく、該電流切り換え手段の非反転駆動出力を並列にレーザの駆動端子に接続することを特長とする請求項２乃至５のうちいずれかに記載のレーザ駆動回路。

【請求項７】前記定電流回路のうちの少なくとも 2 回路に流れる電流が相等しく、該定電流回路からレーザに駆動電流を順次供給するように前記電流切り換え手段が制御されることを特徴とする請求項２乃至６のうちいずれかに記載のレーザ駆動回路。

【請求項８】インダクタのインダクタンスが 1μH 以上であることを特徴とする請求項２乃至７のうちいずれかに記載のレーザ駆動回路。

【請求項９】レーザと、該レーザの戻り光ノイズを低減させる周波数を発生する高周波電流発生手段と、該高周波電流発生手段の出力に接続され該高周波電流発生手段の出力電圧を越え前記周波数のパルス状電圧を発生するインダクタと、該インダクタに流れる電流を 1 方向に制限する整流手段とを有し、該インダクタを流れる電流を前記レーザ駆動電流に加算すること特徴とするレーザ駆動回路。

【請求項１０】並列に並んだ複数のチャネルを用いて半導体レーザを駆動し多値のレーザ光出力を得ることにより光記録媒体上に情報を記録する光学的情報記録方法において、上記個々のチャネルは定電流回路と、該定電流回路に直列接続されるインダクタと、該インダクタを上記半導体レーザに電気的に接続するスイッチ手段を有し、該スイッチ手段を制御することによって、上記複数のチャネルの任意のインダクタより上記半導体レーザに電流を断続的に供給し、多値のレーザ光出力を得る光学的情報記録方法。

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【請求項１１】前記半導体レーザに並列にバイパスを配置し、前記スイッチ手段を制御して、前記インダクタを前記半導体レーザに接続することにより半導体レーザに電流を供給し、前記インダクタを上記バイパスに接続することにより半導体レーザに電流を供給しない請求項１０記載の光学的情報記録方法。

【請求項１２】前記バイパスにはバランス用負荷が配置されている請求項１１記載の光学的情報記録方法。

【請求項１３】正電源及び負電源に対して、上記複数のチャネルが直列に配置され、前記スイッチ手段を制御して、前記インダクタを前記半導体レーザに接続することにより半導体レーザに電流を供給し、前記インダクタを上記定電回路に接続することにより半導体レーザに電流を供給しない請求項１０記載の光学的情報記録方法。

【請求項１４】前記スイッチ手段を制御することにより、光記録媒体上に細長いマークを形成して情報を記録する請求項１０乃至１３のうちいずれかに記載の光学的情報記録方法。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、レーザの駆動回路に関するものである。

【０００２】

【従来の技術】光ディスクは、大量情報の格納が可能で媒体の交換が可能であるという特徴を持ち、現在急速に普及しつつある。この光ディスクの光源には縦単一モードの半導体レーザ・ダイオードを用いることが一般的である。しかし半導体レーザの共振器内に外部からの光が戻った場合、半導体レーザは戻り光ノイズと呼ばれる発光強度の変動を起こす。この戻り光ノイズは再生信号の品質を低下させるので、高密度化を図る上で問題となる。

【０００３】そこでこの問題を解決するため、日本国公開特許広報：昭 56-37834 等で公知であるように、レーザ駆動電流に数十～数百 MHz の高周波電流を重畳することによってレーザの縦モードをマルチ・モード化し、レーザ光の干渉性を低下させて戻り光ノイズを低減する手法が知られている。この従来技術では、レーザに直流電流源と高周波交流電流源を同時に接続し、レーザ駆動電流に高周波電流を重畳する構成をとる。このためレーザ駆動電流の最大値は、直流電流源および高周波交流電流源の電源電圧で制限されている。

【０００４】また光ディスクの一種である光磁気ディスクや相変化型ディスクは、レーザ光源からの光を絞り込んで記録媒体を局所的に加熱し、記録マークを形成することによって情報を記録している。これらの光ディスク装置において、記録情報の信頼性を保ちながら記録密度向上を図るためには、記録マークを縮小しながら、同時にマーク形状を正確に制御することが必要である。この目的で日本国公開特許広報：平 5-298737 等で公知であるように、複数パワー・レベルを持つ光パルスによって記録マークを精密に形成する記録制御技術が開発されている。

【０００５】記録制御を行う場合のレーザ駆動回路の構成例を図 8 に、図 8 に対応したレーザ駆動電流波形とレーザ駆動回路の動作例を図 9 に示す。本構成では 3 系統のカレント・ミラー回路 105a をカレント・スイッチ 103 を介して並列に接続し、記録波形制御回路からの加算制御信号 106 に従い各電流を適宜加算することによって 4 段階のレーザ駆動電流 302 すなわち 4 段階の発光強度レベルを発生している。

【０００６】本回路構成の場合、レーザ・ダイオード 101 にはカレント・スイッチ 103 とカレント・ミラー回路 105a とが直列に挿入され、これらを構成する回路素子によって電圧降下が生ずる。このためにレーザ・ダイオード 101 を任意の発光強度で駆動するためには、レーザ駆動端子間の最大電圧に駆動回路による電圧降下を加えた以上の電源電圧が必要であった。

【０００７】

【発明が解決しようとする課題】光ディスクの記録密度を向上させるためには、使用するレーザ光源の波長を短縮し、記録再生に用いられる光スポットの径を縮小することが最も直接的でありかつ効果的である。現在光源として一般に用いられている半導体レーザ・ダイオードの短波長化は、素子の材料を変更しバンド・ギャップを拡大することによって行われている。しかしバンド・ギャップを拡大するにつれてキャリア濃度を十分に高めることが難くなってきており、これによって材料自体の抵抗率が増大してきている。このため将来の半導体レーザ・ダイオードでは、短波長化にともなう素子材料の変更により、この値がさらに拡大する見込みである。

【０００８】また、記録密度の向上による大容量化にともない、記録再生の速度も高速化する必要がある。このため信号処理を行う回路素子にもより高速な動作が要求されている。一般に高速動作を行う半導体素子は、従来よりも低い電源電圧で動作することが多い。またこれと同時に装置自体の低消費電力化を目的として、電源電圧を低下させる傾向がある。現在では電源として +5V と +12V、あるいは +5Vのみの供給を受けて動作する装置が一般的であるが、将来はこれらが +5V 以下の単一電源となることが予想される。

【０００９】光磁気ディスク装置で光変調方式による記録を行う場合、光源の半導体レーザは大振幅のパルス電流で駆動され、短い幅で高い発光強度レベルの光パルスを発生する。従来の光磁気ディスクのレーザ駆動回路の一例を図 8 に、その動作例を図 9 に示す。また、半導体レーザの駆動特性の一例を図 10 に示す。発光強度 IOUT 1003 を高めるにはレーザの順方向電流 IF 1001 が大きくなりアノード・カソード間電圧 VF 1002 が拡大するので、レーザ駆動電流には電源電圧によって決まる上限値が存在する。すなわち、レーザ駆動回路の電圧降下とレーザ順方向電圧降下の和よりも低い電圧の電源ではレーザを駆動することは不可能である。

【００１０】これらの問題を解決するために、低い電圧の電源を昇圧して連続的に高い電圧を得る DC-DC コンバータ等の手段がある。しかしレーザ駆動回路のためだけにDC-DC コンバータを準備することは、装置の小型化とコストの点で不利である。

【００１１】そこで本発明では、レーザ駆動回路にインダクタを組み合わせることによってこれらの問題を解決し、レーザ順方向電圧降下による電源電圧への制限を緩和する。これにより、半導体レーザの短波長化にともなってレーザの順方向電圧降下が上昇した場合でも、従来よりも低い電源電圧でのレーザの駆動が可能であるため、電源電圧の昇圧が不要となり、消費電力および装置サイズとコストの問題を解決できる。

【００１２】

【課題を解決するための手段】本発明のレーザ駆動回路は、レーザと、該レーザを駆動する電流の大きさを設定する定電流回路と、該定電流回路に直列に接続され該定電流回路に流れる電流の経路を切り換える電流切り換え手段と、前記定電流回路に直列に接続されたインダクタから構成される。さらにレーザ駆動回路を、少なくとも 2 個の定電流回路と、少なくとも 2 個の電流切り換え手段と、少なくとも 2 個のインダクタから構成し、前記定電流回路の個数と、前記電流切り換え手段の個数と、前記インダクタの個数が相等しく、該電流切り換え手段の非反転駆動出力を並列にレーザの駆動端子に接続され、前記定電流回路のうちの少なくとも 2 回路に流れる電流が相等しく、該定電流回路からレーザに駆動電流を順次供給するように前記電流切り換え手段を制御することによって、レーザへの駆動電流を各インダクタから順次交互に供給させ、特定のインダクタがレーザに駆動電流を供給する期間を短縮する。

【００１３】また、レーザの戻り光ノイズを低減させる周波数を発生する高周波電流発生手段と、該高周波電流発生手段の出力に接続されその出力電圧を越え前記周波数のパルス状電圧を発生するインダクタと、該インダクタに流れる電流を 1 方向に制限する整流手段とを有し、該インダクタを流れる電流を前記レーザ駆動電流に加算することによってレーザの駆動電流に十分な振幅の高周波電流を重畳し、戻り光ノイズを抑圧する。

【００１４】以上のとおりインダクタを含みレーザ駆動回路を構成することにより、発光中心波長が 680nm 以下のレーザを電源電圧 5V 以下で前記レーザを駆動する。

【００１５】特に本願発明は、多値レベルの光パルスを組み合わせて、光記録媒体上に精度良くデータを記録するのに好適であり、このために、並列に並んだ複数のチャネルを用いて半導体レーザを駆動し多値のレーザ光出力を得ることにより光記録媒体上に情報を記録する光学的情報記録方法において、個々のチャネルは定電流回路と、定電流回路に直列接続されるインダクタと、インダクタを半導体レーザに電気的に接続するスイッチ手段を有し、スイッチ手段を制御することによって、複数のチャネルの任意のインダクタより半導体レーザに電流を断続的に供給し、各チャネルのインダクタからの合計の電流がレーザを駆動することにより、多値のレーザ光出力を得る。このようにして、従来よりも低い電源電圧で、充分な出力の光パルスを低消費電力にて供給することができる。

【００１６】

【作用】一般にインダクタンス L を持つインダクタに電流 I を流し、その電流を時刻t の経過とともに変化させた場合、そのインダクタの両端には、

$L|dI/dt|$

の大きさで、電流の変化を妨げる方向の起電力が生じる。したがってインダクタと直列に負荷を接続した場合、その負荷の大きさが変化するとインダクタに起電力が生じ、インダクタ自身に流れる電流すなわち負荷電流の変化を最小限とするように動作する。すなわち負荷が大きくなった場合にはインダクタ内部に磁気的な形で蓄えられたエネルギーが電気エネルギーとして放出され、インダクタおよび負荷を流れる電流の減少を最小限に抑えようとする。

【００１７】逆に負荷が小さくなった場合には、電気的なエネルギーを磁気的な形に変えてインダクタ内部に蓄え、インダクタおよび負荷を流れる電流の増加を最小限に抑えようと動作する。電流および電圧を維持できる期間はインダクタのインダクタンスの大きさによって決定され、インダクタンスが大きいほどこの維持時間も長くなる。しかし、これと同時にインダクタにエネルギーを蓄えるための時間も長くなる。またインダクタによって供給する電流を安定にするためには、インダクタに常に十分なエネルギーを蓄えておく必要がある。すなわちこのためには、インダクタからエネルギーを放出する期間がインダクタにエネルギーを蓄える期間よりも十分に短くなければならない。

【００１８】一方、図 8 に示されるような従来のレーザ駆動回路は、駆動電流の大きさを設定するためのカレント・ミラー回路 105a と、レーザ駆動電流に対してカレント・ミラー回路 105a の電流の加算を制御するカレント・スイッチ 103 からなっている。レーザ・ダイオード 101 の駆動電流を増加させるとその順方向電圧降下が大きくなるため、レーザ・ダイオード 101 の順方向電圧降下と駆動回路による電圧降下の和が電源電圧に等しくなる点で駆動電流が頭打ちとなり、それ以上に駆動電流を増やすことはできない。つまり従来のレーザ駆動回路においては、レーザ駆動電流の最大値は電源電圧によって制限されている。

【００１９】そこで図 5 のように、レーザ・ダイオード 101 を駆動するパルス電流の振幅を設定する定電流回路 502 に直列にインダクタ 104 を挿入した場合を考える。インダクタ 104 の内部抵抗は十分に低く、無視し得るものとする。この場合、駆動回路による電圧降下とレーザ・ダイオード 101 の順方向電圧降下の和が電源電圧よりも低い駆動電流の範囲では、駆動回路は従来と同様に動作する。すなわち通常、電流切り換え手段 501 はバランス用負荷 102 側に切り換わっており、定電流回路 502 の設定電流によってインダクタ 104 にエネルギーを蓄えるとともにインダクタ 104 に保持すべき電流の大きさを設定する。

【００２０】レーザ・ダイオード 101 に電流を流す場合には、電流切り換え手段 501 がレーザ・ダイオード 101 側に切り換わり、定電流回路 502 およびインダクタ 104を流れる電流がレーザ駆動電流となる。駆動電流を増加して、駆動回路による電圧降下とレーザ・ダイオード 101 の順方向電圧降下の和が電源電圧の値に近づくと定電流回路 502 の動作が困難となり、インダクタ 104 を流れる電流がわずかに減少する。

【００２１】しかし前述したように電流値を維持する方向の起電力が同時にインダクタ 104に生ずるので、実効的に電源電圧が上昇した場合と同等の効果が得られる。すなわちインダクタ 104 に蓄えられているエネルギーを放出することによって、一時的にレーザ駆動電流を供給することが可能となる。

【００２２】あるいは図 6 に示すように、インダクタ 104 に流れる電流を定電流回路 502とレーザ・ダイオード 101 との間に切り換える場合を考える。通常、電流切り換え手段 501 は定電流回路 502 側に切り換わっており、その設定電流によってインダクタ 104 にエネルギーを蓄えるとともに保持すべき電流の大きさを設定する。レーザ・ダイオード 101 に電流を流す場合には、電流切り換え手段 501がレーザ・ダイオード 101 側に切り換わる。定電流回路 502 による電圧降下よりもレーザ・ダイオード 101 の順方向電圧降下のほうが大きい場合でも、前述したように電流値を維持する方向の起電力がインダクタ 104 に生ずるので、実効的に電源電圧が上昇した場合と同等の効果が得られる。すなわち、インダクタ104 に蓄えられているエネルギーを放出することによって、一時的にレーザ駆動電流を供給することが可能となる。

【００２３】しかし前述のとおり、インダクタ 104 に常に十分なエネルギーを蓄えてレーザ駆動電流の振幅を安定化させるためには、インダクタ 104 にエネルギーを蓄える期間はインダクタ 104 からエネルギーを放出させる期間よりも十分に長くなければならない。すなわち電流切り換え手段 501 が、図 5 においてバランス用負荷 102 側に切り換わっている期間、あるいは図 6 において定電流回路 502側に切り換わっている期間は、電流切り換え手段 501 がレーザ・ダイオード 101 側に切り換わっている期間よりも十分に長くなくてはならない。

【００２４】そこで図 5 あるいは図 6 に示される定電流回路 502、インダクタ 104 および電流切り換え手段 501 からなる駆動回路の最小構成単位（本発明ではこれを「チャネル」と呼ぶことにする）の駆動出力を並列に接続し、その内の複数のチャネル 108 の電流振幅を等しく設定する。こうすればレーザ・ダイオード 101への駆動電流を各チャネル 108 から順次交互に供給させることによって一つのチャネル 108 がレーザ・ダイオード 101 に駆動電流を供給する期間を短縮し、インダクタ 104 に常に十分なエネルギーを蓄えておくことが可能となる。

【００２５】また図 7 に示すように、高周波パルス発生手段 402 とそれによって開閉されるスイッチング手段 701 によって、インダクタ 104 および定電流回路 502 の負荷を断続的に変化させる場合を考える。高周波パルス発生手段 402 は、半導体レーザの縦モードをマルチ・モード化し戻り光ノイズを低減させるのに適した周波数を発生しているものとする。スイッチング手段 701 が閉状態から開状態に変化するのにともない、インダクタ 104 にはレーザ・ダイオード 101 の駆動電流を増加させる方向のパルス電圧が発生する。そこでインダクタ 104 に流れる電流をダイオード 401 で整流し、レーザ駆動電流に加算する。本構成により、インダクタ 104 を流れる電流の時間変化率が所定値以上になるとインダクタ104 に発生するパルス電圧の振幅も十分に大きくなるので、レーザ・ダイオード101 の順方向電圧降下が大きい場合でも、レーザ駆動電流に十分な振幅の高周波電流を重畳することが可能となる。

【００２６】

【実施例】図 1 に本発明におけるレーザ駆動回路の 1 つの回路実施例を示す。本実施例の 1 チャネルは、バランス用負荷 102 とレーザ・ダイオード 101 との間で電流を振り分けるカレント・スイッチ 103 と、カレント・スイッチ 103 に直列に接続されレーザ・ダイオード 101 に対して供給する電流振幅を設定するカレント・ミラー回路 105a とカレント・ミラー回路 105a に直列に挿入されるインダクタ 104 から構成されて、全体として 4 チャネル 108a～108d から構成されている。

【００２７】各カレント・スイッチ 103 は記録波形発生回路からの加算制御信号 106 によって制御され、カレント・ミラー回路 105a およびインダクタ 104 をレーザ・ダイオード 101 とバランス用負荷 102 のどちらに接続するかを切り換える。レーザ・ダイオード 101 とバランス用負荷 102 には各チャネル 108a～108d の非反転駆動出力 109a，反転駆動出力 109b がそれぞれ並列に接続されており、レーザ・ダイオード 101 およびバランス用負荷 102 を流れる電流は各チャネル 108a～108d による駆動電流の和となる。従って、レーザ・ダイオード１０１を多値レベルで駆動することが可能となっている。

【００２８】図 1 各チャネル 108a～108d は通常、カレント・スイッチ 103 がバランス用負荷側 102 に切り換わって（反転側のトランジスタがオン、非反転側のトランジスタがオフ状態）いて、インダクタ 104 にエネルギーを蓄えるとともにインダクタ 104 に定電流を流すことによってそのチャネルがレーザ・ダイオード 101 に供給する電流の大きさを設定している。

【００２９】レーザ・ダイオード 101 に電流を流す場合にはカレント・スイッチ 103 がレーザ・ダイオード 101 側に切り換わり（反転側のトランジスタがオフ、非反転側のトランジスタがオン状態）、インダクタ 104 およびカレント・ミラー回路105a がレーザ・ダイオード 101 に駆動電流を供給する。駆動回路による電圧降下とレーザ・ダイオード 101 の順方向電圧降下の和が電源電圧よりも低くなるレーザ駆動電流の範囲では、駆動回路は従来と同じように動作する。駆動回路による電圧降下とレーザ・ダイオード 101 の順方向電圧降下の和が電源電圧に等しくなるまで駆動電流の振幅を増加した場合、カレント・ミラー回路 105a の動作が困難となりインダクタ 104 を流れる電流がわずかに減少する。

【００３０】しかし作用の項で説明したように、この時には電流値を維持する方向の起電力がインダクタ 104 に生じ、実効的に電源電圧が上昇したのと同等の効果が得られる。すなわち、インダクタ 104 に蓄えられているエネルギーを放出することによって、一時的にレーザ駆動電流を維持することが可能となる。

【００３１】次に図 2 に本発明におけるレーザ駆動回路の他の実施例を示す。本実施例の1 チャネルは、駆動電流の振幅を設定するカレント・ミラー回路 105a と、カレント・スイッチ 103 のコレクタ側に直列に接続されたインダクタ 104 と、インダクタ 104 に流れる電流をカレント・ミラー回路 105a とレーザ・ダイオード101 との間で振り分けるカレント・スイッチ 103 から構成されており、全体として 4 チャネル 108a～108d から構成されている。

【００３２】各カレント・スイッチ 103 は記録波形発生回路からの加算制御信号 106 によって制御され、インダクタ 104 に流れる電流をカレント・ミラー回路 105a とレーザ・ダイオード 101 のどちらに流し込むかを

切り換える。レーザ・ダイオード 101 には各チャネル 108a～108d の非反転駆動出力 109a が並列に接続されており、レーザ・ダイオード 101 の駆動電流は各チャネル 108a～108d による駆動電流の和となる。

【００３３】図 2 の各チャネル 108a～108d は通常、カレント・スイッチ 103 がカレント・ミラー回路側 105a に切り換わって（反転側のトランジスタがオン、非反転側のトランジスタがオフ状態）いて、インダクタ 104 にエネルギーを蓄えるとともにインダクタ 104 に定電流を流すことによってそのチャネルの駆動電流の振幅を設定している。レーザ・ダイオード 101 に電流を流す場合にはカレント・スイッチ 103 がレーザ・ダイオード 101 側に切り換わり（反転側のトランジスタがオフ、非反転側のトランジスタがオン状態）、インダクタ 104 を流れる電流がレーザ・ダイオード 101 の駆動電流に加算される。カレント・ミラー回路105a の電圧降下よりもレーザ・ダイオード 101 の順方向電圧降下の方が大きい場合でも、作用の項で説明したようにインダクタ 104 を流れる電流値を維持する方向の起電力がインダクタ 104 に生じ、実効的に電源電圧が上昇したのと同等の効果が得られる。すなわち、インダクタ 104 に蓄えられているエネルギーを放出することによって、一時的にレーザ駆動電流を維持することが可能となる。

【００３４】図 3 に、図 1 または図 2 の駆動回路を用いて記録制御を行う場合のレーザ駆動電流 302 の波形の一例と、これに対応した加算制御信号 303a～303d の例を示す。

【００３５】図 1 または図 2 のチャネル 3 108c およびチャネル 4 108d は等しい振幅の駆動電流を供給できるようにカレント・ミラー回路 105a の動作電流が設定されており、チャネル 3 108c およびチャネル 4 108d のカレント・スイッチ 103はレーザ・ダイオード 101 に対して駆動電流を順次交互に供給するようにチャネル 3，チャネル 4 の加算制御信号 303c，303d によって制御される。以上の一連の動作により、カレント・スイッチ 103 が反転駆動出力 109b 側に切り換わりインダクタ 104 にエネルギーを蓄える期間を、カレント・スイッチ 103 が非反転駆動出力 109a 側に切り換わりインダクタ 104 からエネルギーを放出する期間よりも長く確保し、インダクタ 104 に十分なエネルギーを蓄えて駆動電流を安定に供給することが可能となる。

【００３６】本発明では短波長光源として、発光中心波長を 680nm、あるいはそれよりも短いレーザ・ダイオードを 5V 以下の電圧の電源によって駆動することを想定している。680nm 帯レーザ・ダイオードを開口数 0.55 の対物レンズと組み合わせた場合、光スポットのサイズから規定される通常の記録再生分解能の限界は約 0.41 μm となり、この光学的条件下で記録に用いられる記録マークの直径は一般的にこの値が下限となる。この最小記録マークを線速度 19m/s の光磁気媒体上に形成する場合、レーザ・ダイオードは光出力 25mW，期間 11ns 程度のパルス発光を行うように駆動される。

【００３７】図 10 に特性を示したレーザ・ダイオードの駆動特性によれば、この時のレーザ順方向電流 IF 1001 は約 80mA、アノード・カソード間電圧 VF 1002 は約 2.3V であるので、記録マークを 1 個形成するためには約 2μJ の電気エネルギーが必要ということになる。

【００３８】この場合、図 8 に示されるような従来のレーザ駆動回路において、チャネルを構成するトランジスタのコレクターエミッタ間電圧を 0.6V、カレント・ミラー回路の出力トランジスタのエミッタに直列に挿入されている抵抗を 20Ω とすると、チャネルによる電圧降下は最大で約 2.8V となる。従ってレーザ・ダイオードによる電圧降下と駆動回路による電圧降下の和は最大で約 5.1V となり、電圧 5V の電源による駆動は不可能となる。一方、インダクタに蓄えられているエネルギーは、インダクタのインダクタンスを L，流れる電流を I とすれば、(1/2)LI^2 で表される。（「^」はべき乗を表す演算子）前述のように 1 個の記録マークを形成するために必要なエネルギーを 1 チャネルすなわち 1 個のインダクタから供給するとすると、このことから L の大きさが制限される。すなわち

(1/2)LI^2 > 2 (μJ)

なる大小関係が満足される必要があり、これを解けば、

0.63 (μH) < L

が得られる。従って本発明においては各インダクタのインダクタンスを少なくとも 1μH 程度以上とすることが好ましい。これ以下であるとインダクタに十分なエネルギーを蓄えることができず、十分にレーザを駆動することができない場合が有る。

【００３９】図 4 に本発明におけるレーザ駆動回路の他の実施例を示す。本実施例では高周波パルス発生手段 402 によって開閉される電界効果型トランジスタ 402 と、カレント・ミラー回路 105b と、インダクタ 104 を直列に接続し、カレント・ミラー回路 105b およびインダクタ 104 の負荷を断続的に変化させる構成となっている。高周波パルス発生手段 402 は、半導体レーザの縦モードをマルチ・モード化し戻り光ノイズを低減させるのに適した周波数を発生しているものとする。電界効果型トランジスタ 403 がオンからオフへ変化すると同時に、インダクタ 104 にはレーザ・ダイオード 101 に電流を流し込む方向のパルス電圧が発生し、ダイオード 401 を介してインダクタ 104 を流れる電流がレーザ駆動電流に加算される。インダクタ 104 を流れる電流の時間変化率が所定値以上になるとインダクタ 104 に発生するパルス電圧の振幅も十分に大きくなるので、レーザ・ダイオード 101 の順方向電圧降下が大きく、従来の通常の高周波重畳回路では出力電圧振幅が不足する場合でも、レーザ駆動電流に十分な振幅の高周波電流を

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重畳することが可能となる。

【００４０】

【発明の効果】本発明によれば、従来に比べてより低い電源電圧で動作可能なレーザ駆動回路を実現することができる。これにより、半導体レーザの短波長化にともなってレーザ順方向電圧降下が拡大した場合等でも電源電圧の昇圧手段を準備する必要がなくなり、低消費電力化および装置の小型化とコストの低減を可能とすることができる。

【図面の簡単な説明】

【図１】本発明の第 1 の実施例を説明する回路図。

【図２】本発明の第 2 の実施例を説明する回路図。

【図３】本発明の第 2 の実施例の動作例を説明する波形図。

【図４】本発明の第 3 の実施例を説明する回路図。

【図５】本発明の第 1 の発明の原理的構成を説明する回路図。

【図６】本発明の第 2 の発明の原理的構成を説明する

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回路図。

【図７】本発明の第 3 の発明の原理的構成を説明する回路図。

【図８】記録制御に対応した従来のレーザ駆動回路の構成例を説明する回路図。

【図９】記録制御に対応した従来のレーザ駆動回路の動作例を説明する波形図。

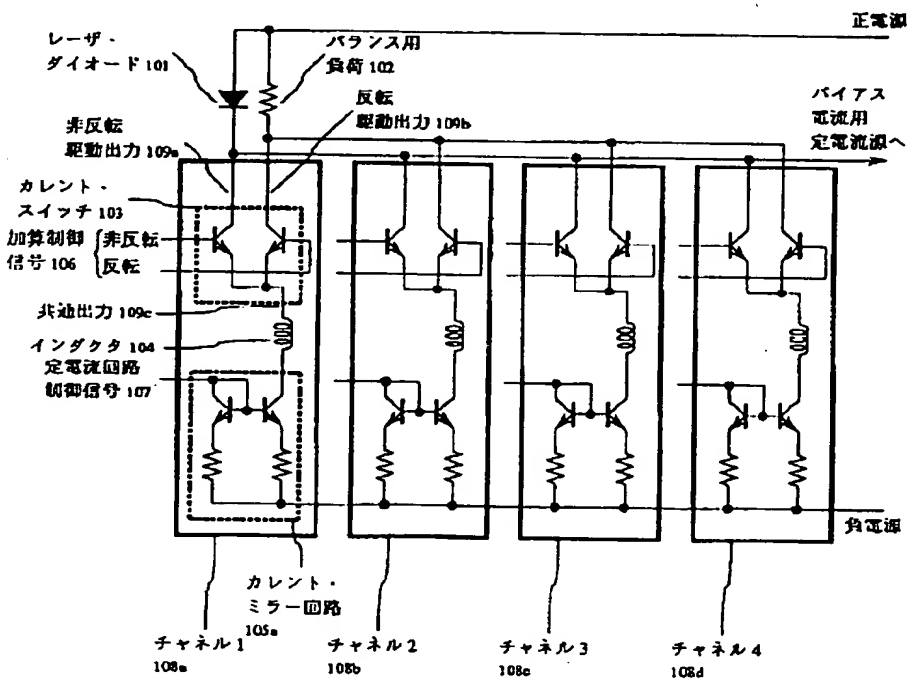
【図１０】半導体レーザの駆動特性の例を説明するグラフ図。

【符号の説明】

101…レーザ・ダイオード、102…バランス用負荷、103…カレント・スイッチ、104…インダクタ、105a,105b…カレント・ミラー回路、106…加算制御信号、107…定電流回路制御信号、108…チャネル、109a…非反転駆動出力、109b…反転駆動出力、109c…共通出力、302…レーザ駆動電流、401…ダイオード、402…高周波パルス発生手段、403…電界効果型トランジスタ、501…電流切り換え手段、502…定電流回路、701…スイッチング手段。

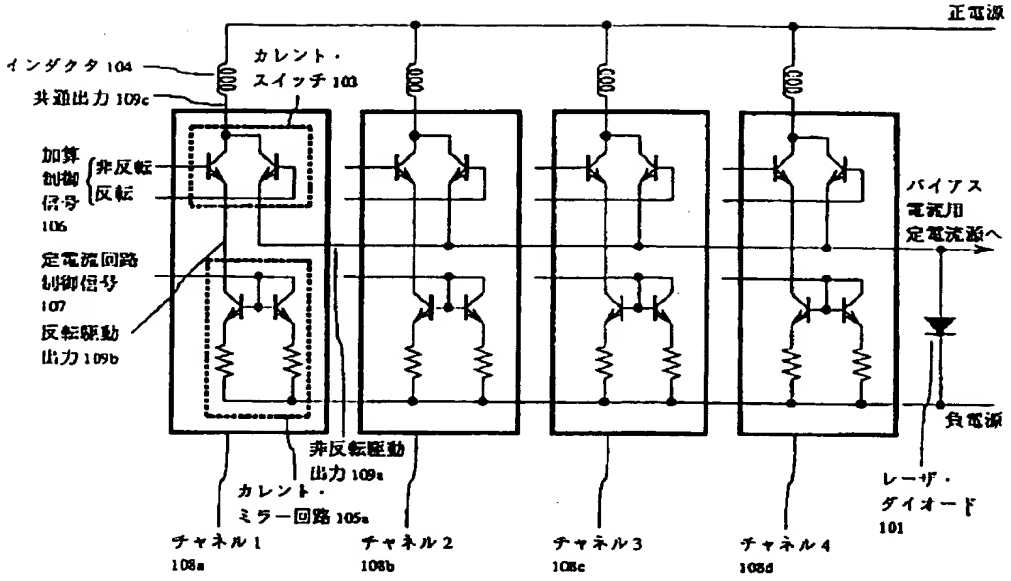
【図１】

図 1



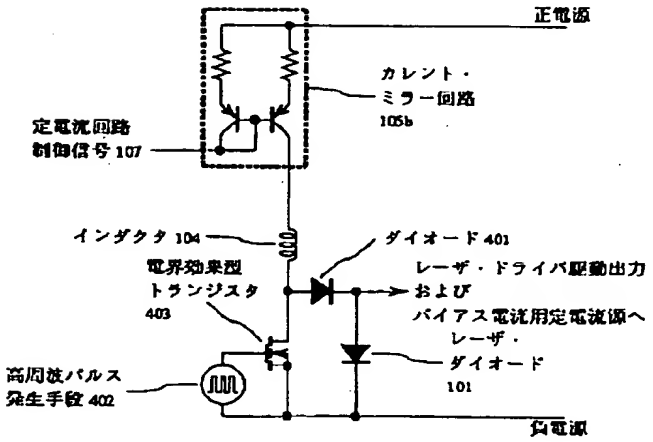
【図２】

図２



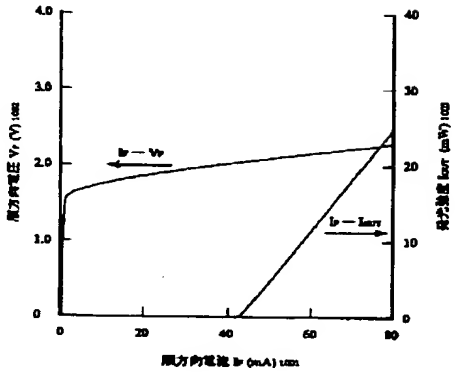
【図４】

図４



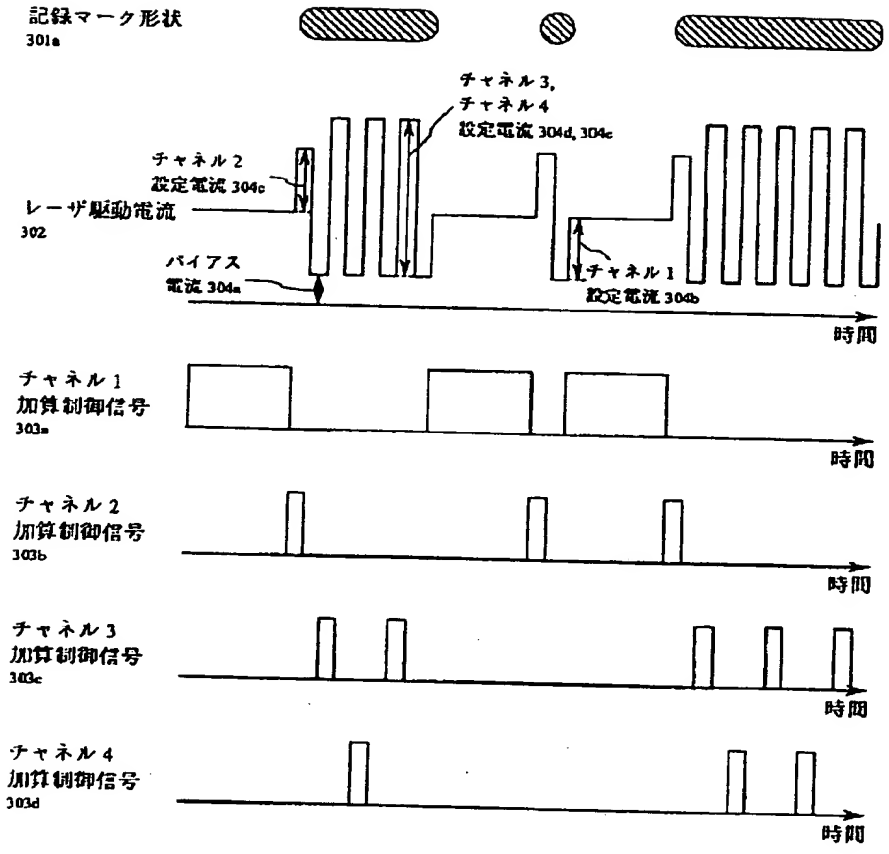
【図１０】

図 10



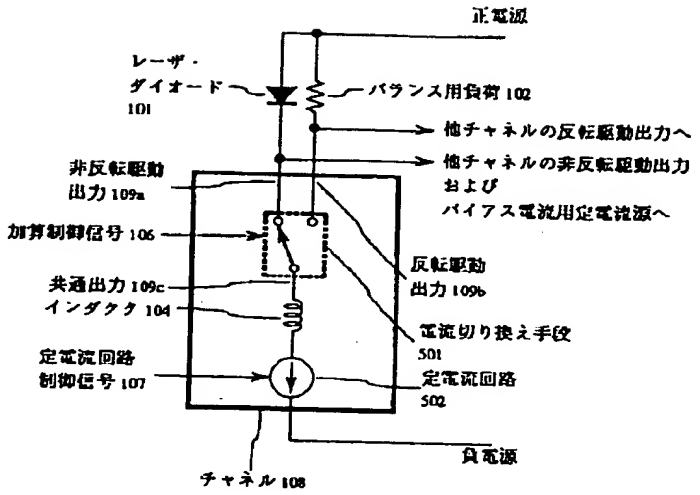
【図３】

図３


記録マーク形状
301a
チャネル3,
チャネル4
設定電流 304d, 304c
チャネル2
設定電流 304c
レーザ駆動電流
302
バイアス
電流 304a
チャネル1
設定電流 304b
時間
チャネル1
加算制御信号
303a
時間
チャネル2
加算制御信号
303b
時間
チャネル3
加算制御信号
303c
時間
チャネル4
加算制御信号
303d
時間

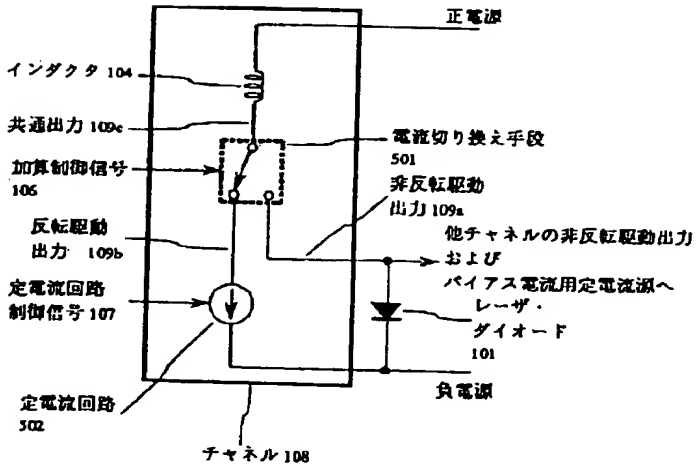
【図５】

図５


正電源
レーザ・
ダイオード
101
バランス用負荷 102
他チャネルの反転駆動出力へ
他チャネルの非反転駆動出力
および
バイアス電流用定電流源へ
非反転駆動
出力 109a
加算制御信号 106
反転駆動
出力 109b
共通出力 109c
インダクタ 104
電流切り換え手段
501
定電流回路
制御信号 107
定電流回路
502
負電源
チャネル 108

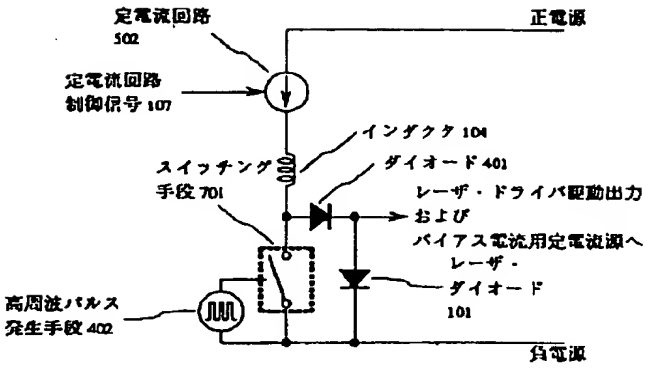
【図６】

図６


正電源
インダクタ 104
共通出力 109c
電流切り換え手段
501
加算制御信号
106
非反転駆動
出力 109a
反転駆動
出力 109b
他チャネルの非反転駆動出力
および
バイアス電流用定電流源へ
定電流回路
制御信号 107
レーザ・
ダイオード
101
負電源
定電流回路
502
チャネル 108

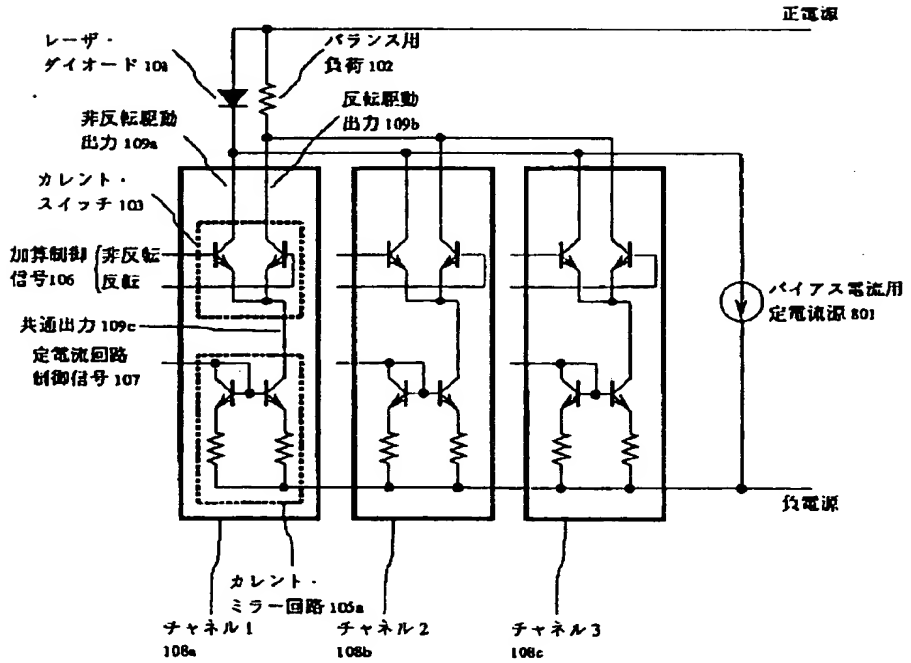
【図７】

図 7


定電流回路
502
正電源
定電流回路
制御信号 107
インダクタ 104
スイッチング
手段 701
ダイオード 401
レーザ・ドライバ駆動出力
および
バイアス電流用定電流源へ
レーザ・
ダイオード
101
高周波パルス
発生手段 402
負電源

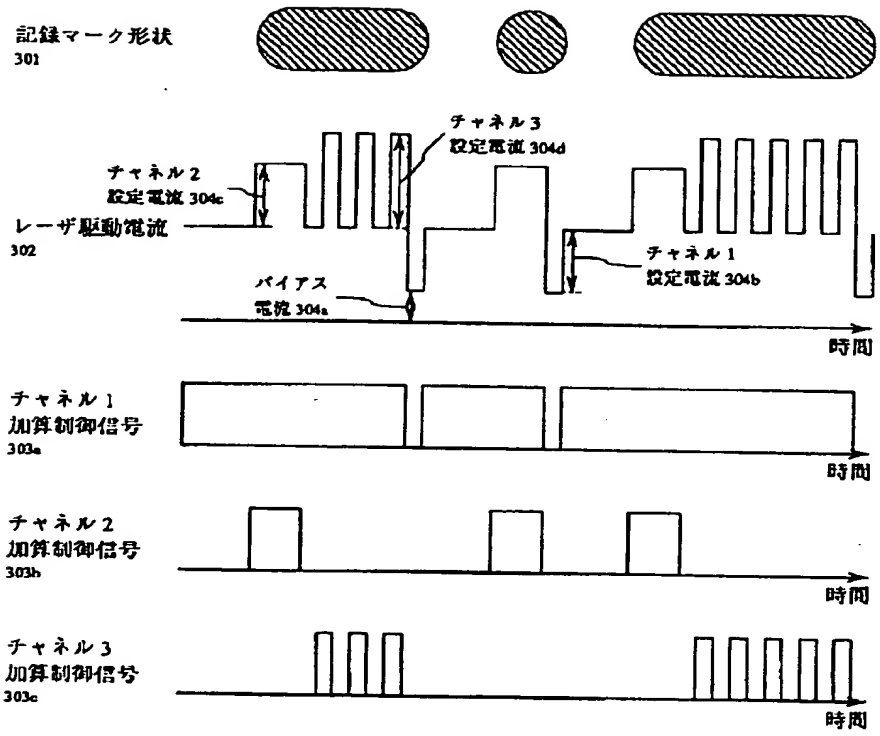
【図８】

図 8


正電源
レーザ・
ダイオード 101
バランス用
負荷 102
反転駆動
出力 109b
非反転駆動
出力 109a
カレント・
スイッチ 103
加算制御
信号 106
非反転
反転
共通出力 109c
定電流回路
制御信号 107
バイアス電流用
定電流源 801
負電源
カレント・
ミラー回路 105a
チャネル 1
108a
チャネル 2
108b
チャネル 3
108c

【図９】

図９


記録マーク形状
301
チャネル３
設定電流 304d
チャネル２
設定電流 304c
レーザ駆動電流
302
チャネル１
設定電流 304b
バイアス
電流 304a
時間
チャネル１
加算制御信号
303a
時間
チャネル２
加算制御信号
303b
時間
チャネル３
加算制御信号
303c
時間